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A Gate Way to Food Security in Africa

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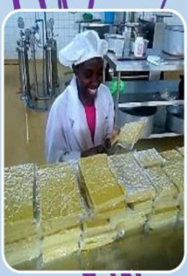




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"ICAAT 2022"

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Our love-for-you won't cease

SCHOOL OF AGRICULTURE AND AGRICULTURAL TECHNOLOGY

The School of Agriculture and Agriculture Technology was established in January 1986 with two Departments (Animal Production and Crop Production) and four pioneer academic staff (Dr. Z. Stecki, Dr. S. Plonka, Mr. E. K. Tsado and Mr S. L. Lamai). With subsequent development, four more departments (Soil Science and Land Management, Water Resources, Aquaculture and Fisheries Technology and Agricultural Economics and Farm Management and Agricultural Extension and Rural Development) were created. The Department of Soil Science started as a Unit under the Department of Crop Production in1987 and attained full status as a Department in 1988 and name was changed to Department of Soil Science and Land Management. The Department of Fisheries Technology, now known as Department of Water Resources, Aquaculture and Fisheries Technology started in 1987 as a Unit in the department of Animal Production which transformed to the Department of Animal Production and Fisheries Technology in 1989 and was split into department of Animal Production and Department of Fisheries Technology in 1991. The Department was repackaged and renamed Department of Water Resources, Aquaculture and Fisheries Technology in 2006. A new Unit, Agricultural Economics and Extension Technology was created during the 1997/1998 section under the Department of Crop Production. The Unit was separated from the mother Department and upgraded to a full-fledge Department in 2002. Approval has also been given for creation of Department of Agricultural Extension and Rural Development while the mother Department will henceforth bear Department of Agricultural Economics and Farm Management.

In 1997, the proposed Department of Food Science and Nutrition took off as a Unit in the Department of Animal Production and became a full-fledged Department of Food Science and Technology. Similarly, the Horticulture unit has emerged in the Department of Crop Production and it is hoped that, in due course, a separate Department of Horticulture will be created.

The student intake into the School at inception in 1986 stood at two (one student each for Department Of Animal Production and Department Of Crop Production), and these graduated in 1989. Since then, the school has witness tremendous progress in terms of staff recruitment and development, infrastructural development and student enrolment. Today, the staff and student population stand at 107 and 1,444 respectively.

Dr. Z. Stecki was the first Coordinator for the school (1986 September 1988). Dr. E.A. Salako took over as School Coordinator from October 1988 to 1990 and served later as Acting Dean until he became the only Professor in the School when he was made the Dean. After his tenure, the school reverted to the position of Acting Deanship since no Professor was on ground then. These were Dr. J.A. Oladiran (1995-1998) and Dr. S.L. Lamai (1998-2001). By September 2001, with more Professors on ground portraying the extent of development, the Board of School of Agriculture and Agricultural Technology, in accordance with the University regulations, elected Prof. O.O.A. Fasanya as the Dean of the School for a two-year term. Since then, the Deanship position in the school has been filled by election. Prof. E.A. Salako took over from Prof O.O. A. Fasanya in 2003 and Prof. S.L. Lamai took over from Prof. E.A. Salako in 2005. In January 2008, following the appointment of Prof. S.L. Lamai as the Dean of postgraduate school, Prof. K.M. Baba assumed Deanship of the School. In February 2012, Prof. M.G.M. Kolo succeeded Prof. K.M. Baba who had completed his second two-year term. Professor Kolo was re-elected another term of two years from February 2014. While servicing the second term, he was appointed Dean of Postgraduate School which necessitated another election leading to the emergence of Prof. R.J. Kolo the new Dean in March 2015. Following the completion of the second term of Prof. Kolo, elections were conducted and Prof. A. J. Odofin emerged as the Dean as from 9th of April 2019. Presently, the Dean of the School is Prof. J.N. Nmadu, he is a Professor of Econometric.

INTERNATIONAL CONFERENCE OF AGRICULTURE AND AGRICULTURAL TECHNOLOGY

The Committee of the 2nd International Conference of Agriculture and Agricultural Technology (ICAAT 2022) is pleased to announce the conference. This conference is an avenue to disseminate innovative research results and latest development in technologies related to agriculture which are aimed at improving food security and reduce risks faced by farmers due to climate change. The conference will bring together leading researchers and scientists in agriculture and allied fields, and even commoners in the domain of interest from around Africa and the world. This international conference brings together experts, intelligentsia and potential researchers from various fields of agriculture to cross fertilize ideas and ponder on the recent innovations and techniques aimed at focusing on climate change, tradeoffs that exist between productivity, adaptation and mitigation in Africa. Therefore, during the three-day conference, all participants will have plenty of opportunities for exchanging ideas, findings and the latest research results.

PROGRAMME OF EVENTS

	Sunday, 11th December, 2022
4.00 pm	Arrival of Participants and Settling in
DAY TWO	Monday, 12th December, 2022
	Opening Ceremony
8.00 – 9.40 a.m.	Registration of Participants
9.45 - 10.00 a.m.	Arrival of Dignitaries and Participants
10.00 a.m.	University Anthem
10.05 a.m.	Opening Prayer
10.10 a.m.	Address by the Dean School of Agriculture and Agricultural Technology
10.15 a.m	Welcome Address by the Vice Chancellor, Federal University Technology, Minna
10.20 a.m.	Keynote Address by Prof. Kingsley Kwabena AYISI Director, Risk and Vulnerability Science Centre (RVSC) & Coordinator: VLIR Inter University Cooperation (Belgium), University of Limpopo, South Africa
10.50 a.m.	Goodwill Messages
11.00 a.m.	Entertainment
11.20–11.50 a.m.	
	Chairman, Prof. K.M. Baba
11.10 a.m.	Vote of Thanks by LOC Chairman, Prof. E.Z. Jiya
11.50-12.00 noon	Brunch Break
12.00 – 1.30 p.m.	Scientific Session 1- Venue Agric Phase II Building
1.30 – 2.00 p.m.	Lunch Break
2.00–4.30 p.m.	Scientific Session 2 - Venue Agric Phase II Building
DAY THREE	Tuesday, 12th December, 2022
10.00 – 12 noon	Scientific Session 3 - Venue Academic Publishing Unit
12.00 noon	Excursion/ Departure

Scientific Sessions by Date and Time		
Scientific Session 1	Monday, 12th December, 2022	12.00 – 1.30 p.m
Scientific Session 2	Monday, 12th December, 2022	2.30 – 4.30 p.m.
Scientific Session 3	Tuesday, 13th December, 2022	10.00 – 12 noon

Scientific Sessions by Subject, Venues, Chairs and Rapporteurs

Sessions	Subject	Venue	Chairman	Rapporteur
1, 2 and 3	Crop Science/Production, Horticulture, Forestry and Wildlife Study	Agric Phase II PG Hall 1	Prof. M.T. Salawudeen	Dr Mrs M.O. Ojo
1, 2 and 3	Soil Science, Environmental Management and Agricultural Engineering	Agric Phase II PG Hall 2	Dr B.A. Lawal	Dr Mrs D.T. Ezekiel-Adewoyin
1, 2 and 3	Agricultural Economics, Extension and Rural Sociology	Agric Phase II PG Hall 3	Prof J.H Tsado	Dr Mrs A.S. Oseghale
1, 2 and 3	Animal Science/Production, Aquaculture and Food Science	Agric Phase II PG Hall 4	Prof O.R. Ojutiku	Dr Mrs. K.E. Akande

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WELCOME ADDRESS BY THE DEAN, SCHOOL OF AGRICULTURE AND AGRICULTURAL TECHNOLOGY, MINNA ON THE OCCASION OF THE OPENING CEREMONY OF THE 2ND INTERNATIONAL CONFERENCE OF AGRICULTURE AND AGRICULTURAL TECHNOLOGY (ICAAT) HELD ON DECEMBER 12TH AND 13TH, 2022 AT THE CAVERTON LECTURE THEATRE AT 10.00AM PROMPT

Protocols:

It gives me pleasure to welcome you all to the second ICAAT being held today. For me, the conference is a unique one. When the First edition was held in 2019, I was the Chairman of the Conference Planning Committee for the School that prepared and held a very successful conference. The second edition is holding today when I am the Dean of the School of Agriculture and Agricultural Technology. It goes to show that continuity is possible if firm foundation is laid. I wish to commend the dogged efforts of the Planning Committee led by Prof. Elisha Z. Jiya for working assiduously to make this conference a reality. As at one month ago, one could not imagine that this conference can hold but the Committee made it possible.

2. This is an international conference which is being streamed live as we have participants from Ghana, Germany, South Africa, Ethiopia, India, Kenya, the United Kingdom and the United States. This year is also recording a breakthrough as two international experts from India and Ethiopia joins the Conference Planning Committee. This is a great improvement from the first one which had participants from two other countries apart from Nigeria. We do hope that the third edition would even become more internationally accepted as more countries join
3. I wish to welcome our new, amiable, and smiling-releasing Vice Chancellor, Prof. Faruk Adamu Kuta, to this Conference and congratulate him on his appointed as the 8th Vice Chancellor of this great University.
   Again, there is some unique issues about the conference holding at this time. The first edition held when the former Vice Chancellor, Prof. Abdullahi Bala, assumed office newly just as in the case of our new VC. This event could have passed as the First Official function of the new VC if not that he was said to have commissioned a project last week. Mr. Vice Chancellor Sir, I, on behalf of the School of Agriculture and Agricultural Technology, wish you a very successful tenure in good health. The School of Agriculture and Agricultural Technology will continue to give you all the support, but, at the same time, we have pressing issues that would certainly demand your action which we shall bring to your notice!
4. The theme of this conference: Climate-Smart Agriculture in the post COVID-19 era: a gate way to food security in Africa is topical. Climate change has made it difficult for farmers who are relying on the climate to produce food and raw materials for our industries. Most of the farmers also rely on low technology which is characterized by labour- and land- intensity. The seeds and other inputs are best suited to natural climate which is time neutral. But, with the ravages of climate change, we are witnessing shortage of rainy season, less amount of rainfall, rising temperatures, unreliable forecasts, increased weather hazards like flooding, draught and a number of other constraints. In the face of all these daunting challenges, the farmer needs to adopt some smart moves to outwit the climate. But in order to do that, new technologies for

production must be produced. Therefore, the main target of this conference is to harness together such technologies that would ensure that the farmer's smartness produce desirable results. That would ultimately lead to increase in food production which must also be complimented by storage and processing technologies so as to minimize losses and wastages. At the end of this conference, the participants would come up with recommendations of new technologies that would make the farmers more successful in their business.

5. I welcome all our participants, especially those from other countries, some of who are participating virtually. The Federal University of Technology, Minna is a cosmopolitan University with serene environment for your maximum comfort. Enjoy the various cultures of the Gwaris and Nupes and their cuisines. Find time to visit the Gidan Kwano Community and enjoy a meal of pounded yam with native soups. At the end, return home peacefully with souvenirs from Bida brass work, Ladi Kwali Pottery Centre Minna and a host of various works of arts.
6. Let me express our sincere gratitude to our supporters: Central Bank of Nigeria, Hybrid Feed Ltd, Firdaus Agro Vet, KFF and Agromart Consultancy Nigeria. We really appreciate your gestures and do hope that this would be a beginning of some good things to come.
7. This conference series is planned to hold every other year, but as you can observe, the second one is holding after four years. Even the first one was postponed severally because of ASUU strike. It is my believe that ASUU strike should not stop conferences from holding, after all, research and community development is never affected by such action. Therefore, barring any unforeseen circumstances, I wish to invite you to the third ICAAT which would hold in July 2024.

   Thank you for your kind attention.

Prof. J. N. Nmadu
Dean, School of Agriculture and Agricultural Technology
December 12, 2022

SUSTAINABLE CROP PRODUCTION PRACTICES FOR CLIMATE RESILIENCE FOOD AND NUTRITION SECURITY

Keynote Paper
Presented by:

Prof K.K AYISI

Director, Risk and Vulnerability Science Centre (RVSC) & Coordinator:
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INTRODUCTION

Sub-Saharan Africa is dominated by subsistence or small-scale agriculture, which is especially vulnerable to climate change and climate variability due to the effects of drought, floods, and heat waves. Currently, the system is characterized by high susceptibility to climate threats and little adaptability. Consequently, Africa's agriculture must undergo a substantial transformation to prevent and adapt to the problems posed by climate change, for improved food security, reduced poverty, and increased livelihoods. The smallholder system is still relevant in food security, supporting the livelihood of two to three billion people in the world (Woodhill et al., 2022). All involved parties must do more to support the system and make it resilient. To build resilience to climate change, and achieve food security, there is a need for greater adoption of climate smart agricultural (CSA) technologies. This report describes some of the CSA efforts conducted at the University of Limpopo Risk and Vulnerability Science Centre (RVSC) to address the harsh realities and repercussions of climate change to achieve food and nutritional security.

The Risk and Vulnerability Science Centre

Risk and Vulnerability Science Centre (RVSC) is an initiative of the Department of Science and Innovation (DSI) and the National Research Foundation (NRF) of South Africa, with a primary focus on innovation for a knowledge-based economy. Five key Global Change Grand Challenges (the Global Change Research Plan) for the National System of Innovation have been identified, one of which is Science and Technology in response to global change. Global change refers to the interlinked changes that are altering our contemporary earth at an unprecedented and accelerating rate. The establishment of the RVSC is in line with this Grand Challenge, which deals with the enhancement of scientific understanding of global change and the development of innovations and technologies to respond to change. University of Limpopo (UL) is one of the five universities in South Africa currently running the centres. The global change research plan has currently identified four major cross-cutting knowledge challenges and 15 key research themes as presented in Table 1 below:

Understanding a changing planet	Reducing human footprint	Adapting the way we live	Innovation for sustainability
1. Observation, monitoring & adaptive management 2. Dynamics of the oceans 3. Dynamics of the complex earth systems 4. Linking the land, air and sea 5. Improving model predictions at different scales	1. Waste minimisation methods & technologies 2. Conserving biodiversity and ecosystem services. 3. Institutional integration to manage ecosystems and ecosystem services	1. Preparing for rapid change and extreme events 2. Planning for sustainable urban development. 3. Water Security 4. Food and Fibre security 5. Human health	1. Dynamics of transition at different scales - Mechanisms of innovation & learning; Doing more with less (efficiency) 2. Resilience & Capability to global change (Community cohesion) 3. Options for greening the developmental state

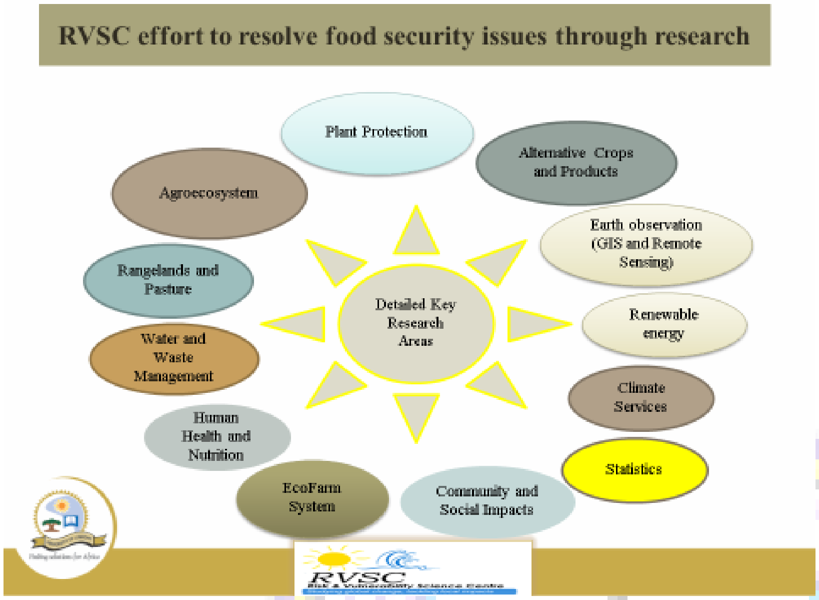
The research plan is designed to contribute to the transformation of South Africa into a knowledge-based economy to support science and technology, as well as key social, and economic development and environmental management.

RVSC Goal:
Assist decision-makers in identifying risks that will enable planning and mapping a future that will be more resilient to climate change for the country and improve the flow of information from the researchers to society.

RVSC Mandates:
To:

1) Generate up-to-date data and information for key sectors to support strategy development and decision-making in areas of risk and vulnerability, thereby supporting South Africa's transition to a resilient future.
2) Contribute to Human Capital Development on issues of climate change through postgraduate student development, staff development, internship and research collaborations with relevant stakeholders and the local community at large.
3) Provide information that will effectively bridge the gap between science and policy through improved access to information.
4) Provide risk and vulnerability assessment services to local communities.
5) Develop next-generation leaders who will have a deeper understanding and appreciation of environmental challenges and sustainability and hence can provide the needed support.

CURRENT RESEARCH ACTIVITIES-RVSC



APPROACH TO ACHIEVING FOOD AND WATER SECURITY RESEARCH MANDATES

The adoption of climate smart agricultural practices is the key approach to attaining food and water security at the RVSC.

JUSTIFICATION OF CSA

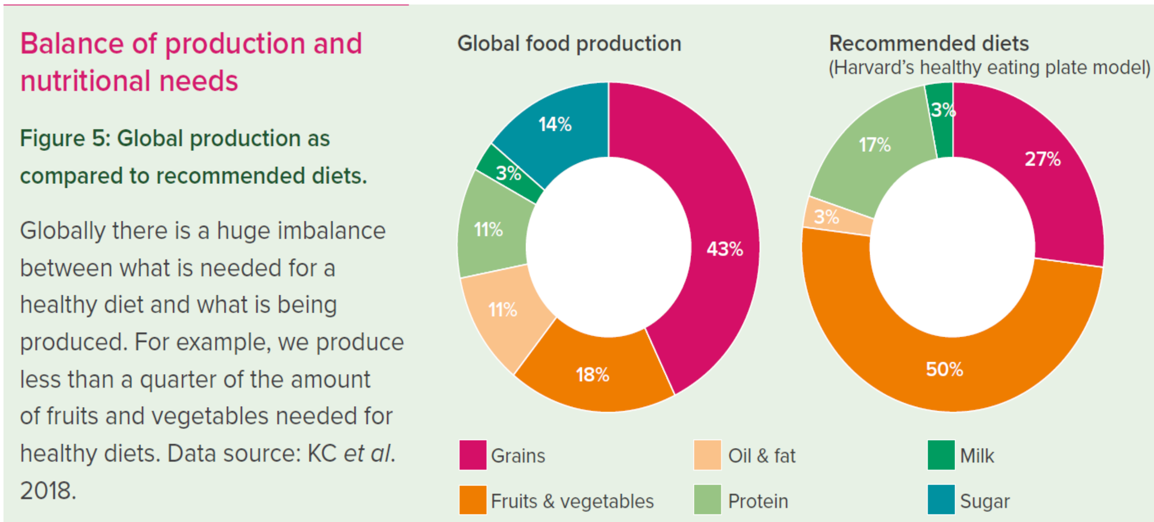
Climate change will impact agricultural productivity and food security in several ways, which extends to the following:

1) Reduced productivity, production stability and incomes; 2) Shift of production season; 3) Changes in pest and disease patterns; 4) Changes in choice of crop and livestock species, varieties or breeds; etc.
2) Human migration- The majority of the people will leave in the cities, implying a reduction in rural agriculture.
3) Given the current population growth projections and food consumption patterns, there are all indications that agricultural production will need to increase by at least 50-70 % to meet food demands by 2050. The current average population increase is estimated at 82 million people per year. The estimates show that the world population will grow from the current 6.7 billion to 9 billion by 2050 with most of the increase occurring in South Asia and sub-Saharan Africa.
4) Current farming practice is chemical intensive creating environmental and health concerns, monoculture system with less agrobiodiversity, and intensively dependent on fossil fuels creating mitigation concerns.

The food production and human nutritional dynamics:

The world is producing enough grains, oils and fats to meet the nutritional needs of the human population, but there is an inadequate supply of fruits, vegetables and protein. CSA must begin to focus on the shortfalls whilst maintaining or enhancing grain crop production.

Food production and nutritional requirement balance.



The human migration dynamics:

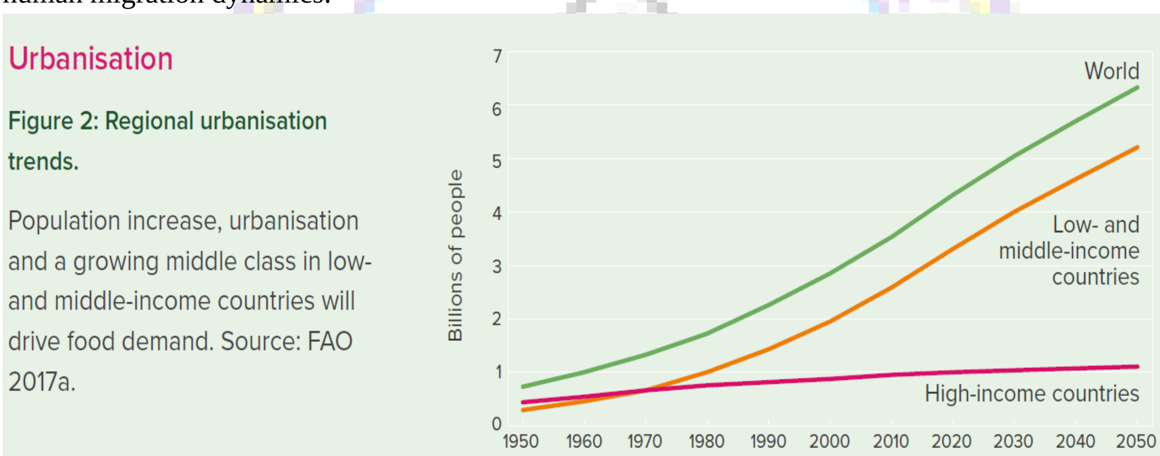


Fig. 1: Global food production and recommended dietary needs and the human migration dynamics (Woodhill et al., 2020).

The world is producing enough grains, oils and fats to meet the nutritional needs of the human population, but an inadequate supply of fruits, vegetables and protein. CSA must begin to focus on the shortfalls whilst maintaining or enhancing grain crop production. The world population is rapidly increasing and the largest increase will come from low and middle-income countries. This is a wake-up call for these countries.

CLIMATE SMART AGRICULTURE

CSA is an agricultural system that continuously increases productivity, not affected drastically by the changes in climate (adaptation), and reduces or removes Greenhouse Gases (GHGs) (mitigation), leading to the achievement of national food security and development goals."

CSA is anchored on the following three principles or pillars:

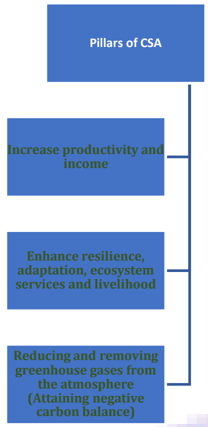


Fig. 1. Pillars of climate smart agriculture

STRATEGIC APPROACH TO CSA IMPLEMENTATION AT RVSC:

The centre has adopted a Co-Design strategy to implement its CSA activities for improved adoption by target groups and long-term societal effects. The approach is firmly based on agroecological principles and focuses on: (1) increasing the efficiency of existing systems; (2) reducing or replacing conventional inputs and practices with eco-friendly alternatives; and (3) redesigning agroecosystems with ecosystem functions and services as the basis. The target beneficiaries are pivotal in the co-design of implementable technologies.

Specific CSA activities

Some of the specific CSA activities at the RVSC include the following:

1) Conservation agriculture: This focuses on three requirements 1) minimum soil disturbance, 2) maximum soil cover 9mulching, cover cropping, etc) and 3) crop diversification, in space (intercropping, agroforestry, etc,) or in time (rotation, fallow, cover cropping).
2) Plant nutrition: Conventional and eco-friendly approaches are compared to find an appropriate balance. These include on-fam manure, green manure, vermiculture, composing, etc.
3) Nanotechnology research with the application of commercial micronutrients primarily Zn and Cu to boost nutrient use efficiency and downsize conventional inorganic fertilizer inputs.
4) Soil and plant health: This entails integrated pest and disease management strategies, cultivar selection, soil-borne disease, pest control, etc.
5) Crop modelling
6) GIS and Remote Sensing for precision agriculture
7) Indigenous and underutilised crops in smallholder and commercial farming systems.

CONCLUDING REMARKS

Climate change is real, and there is already a threat to food security. All parties must make a deliberate, determined effort to adapt to the threat while keeping mitigating concerns in mind. Relevant stakeholders include academic institutions, research institutions, government, business sectors, NGOs, etc., but farmers and civil society, in general, are the most significant. In implementing climate smart approach to solve food security, the following essential principles must be taken into consideration:

1) Increase crop resilience and productivity to drought heat and floods for increased productivity.
2) Provide multiple benefits such as greater productivity, carbon sequestration, and rehabilitation of degraded lands in addition to the adaptation to climate change.
3) Adopt a value chain approach to move commodities from production fields to the consuming public, being mindful of waste and losses.
4) Promote women's capacity to adapt to enhance gender equity and increase women's resilience in the face of climate change.
5) Manage climate risk through better services through the generation and dissemination of agro-advisory services, including weather information, insurance, microfinance, credit and access to markets.
6) Invest in CSA. This section is to address national policies for increasing investment in CSA in order to transform agriculture into a profit-led enterprise *(Investment in agriculture as a driver of development has waxed and waned over the decades (FAO 2017)*. Government and the private sector have a key role to play in this.

REFERENCE

Woodhill, J., Hasnain, S. and Griffith, A. 2020. Farmers and food systems: What future for Small-scale agriculture? Environmental Change Institute, University of Oxford, Oxford.

AGRICULTURALECONOMICS EXTENSION AND RURAL SOCIOLOGY

1 ADOPTION INDEX OF MAIZE PRODUCTION TECHNOLOGIES AND CORRELATION MATRIX IN SMALLHOLDER SYSTEMS

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Abstract

Despite the economic importance of maize in Nigeria, it has not been produced to meet food and industrial demand. This could be attributed to low productivity from maize farms due to non-adoption of improved technologies by farmers. This study analyzed the index of adoption of maize production technologies and the correlations of adoption cost, index and output of smallholder farming systems in Toro, Bauchi State, Nigeria. Multistage sampling technique was adopted in selecting 101 respondents for this study. Primary data collected were analyzed using Adoption index and Multivariate Correlation Techniques. Findings from the study revealed that most (61.4%) of the farmers have low adoption index of ≤0.39. In addition, the results revealed that there was a significant linear relationship between the multivariate factors (farm output, adoption cost and adoption index). The estimated correlation coefficients for r_{xz}, r_{yz} and r_{xy} were -0.65, 0.52 and 0.58 respectively. Subsidizing cost of production technologies, improving access to agricultural technology, credit, extension contact, labour supply and tenure policy modifications are strongly recommended to ameliorate adoption constraints.

Keywords: Adoption, correlation, maize farmers, production technology, yield

Introduction

Maize (*Zea mays*) is a cereal produced across the world. Maize is one of the most important cereal crop cultivated in the rainforest and derived savannah zones of Nigeria. Maize has now risen to a commercial crop on which many agro-based industries depend on as a source of raw material (Iken and Amusa, 2004). It is a high yielding crop, easy to process digested with cost advantage when compared to other cereals (IITA, 2001). It plays an important role both in terms of food security and nutritional intake accounting for about 43% of calorie intake with a daily consumption quantity of 53.20g per capita (Komolafe *et al*., 2010). It is also used extensively as the main source of calories in animal feed formulation (Idrisa *et al*., 2012). Maize is used as a staple human food, feed for livestock, raw material in agro-industries and industrial products; it is also useful in preparation of medicines (Saka and Lawal, 2009; Ouma *et al*., 2002). It constitutes a staple food in many regions of the world particularly in developing countries (Abebaw and Abelay, 2001). Maize is a staple food of great economic importance in the sub-Saharan Africa of which Nigeria is inclusive. In Nigeria, it is the third most important cereal crop after sorghum and millet; globally it is one of the three most important cereals after wheat and rice, with the widest distribution of any cereal (Matata *et al*., 2010; Bonabana-Wabbi, 2002). In some countries, maize is the most

important foodstuff and in particular provides the daily bread for indigenous population of rural communities. According to them, the crop is primarily grown for its grain which is consumed as human foods. In some developed countries, maize is also grown for animal feed and as a base for industrial products such as oil, syrup and starch. Maize is the second most important cereal crop in the world in terms of acreage and production. Global production of Maize was about 1040 million MT in the year 2016–2017, wherein USA and China contributed about 38 and 23%, respectively. Maize can be cultivated successfully in loamy sand to heavy clay, well aerated, neutral pH soils. Furthermore, extended low temperature of less than 5°C severely affects the crop; hence, temperature of ranging between 25°C-35°C is ideal for optimum growth and yield. Maize crop can be cultivated throughout the year with high yield levels. The average yield of maize in Nigeria is about
2500–3500 kg/ha of threshed grain using recommended fertilizers, varieties, seed-dressing, and improved cultural practices (Ali-Olubandwa *et al*. 2010). The total land area planted to maize in Nigeria is above 2.5 million hectares with an estimated yield of about 1.4 metric tons per hectare, though, maize production is still very low especially if considered in relation to the growing food demand of the country (Idrisa *et al*., 2012). About 20% is processed for secondary uses (Iken and Amusa, 2004).

Growth in maize utilization has been driven by the rapidly increasing demand for maize as livestock feed, food and industrial non-food products. The population of Nigeria is expected to grow at a rate of more than 3% per year, while food production is likely to grow at a rate of 2% or less a year. Closing this gap and increasing food production will require intensive agriculturally based use of modern technologies such as the use of improved seed varieties, agrochemicals, management practices, etc. Higher solar radiation received in the northern part of the country relative to the southern part, increases the potential of maize production in the northern zone (NAERLS & FDAE, 2014). Improved agricultural practices are farming practices that have been researched on, tried and found to bring about increased crop yield (Ali-Olubandwa *et al*. 2010). The practices include use of certified seeds, agronomic practices, fertilizer and agrochemical application among others. Ouma *et al*. (2002), defined adoption as a decision to make full use of an innovation or new technology as the best opportunity available to the farmers. In view of the uncertainty about the outcome or otherwise profitability of such innovation, a greater effort is required of the farmers so as to decide whether to use the innovation or not. Agricultural productivity in the developing countries like Nigeria continues to be low and it is generally believed that non-adoption of research results by majority of farmers is the main reason for this situation (Idrisa *et al*., 2012). Bawa and Ani (2014), found a positive and significant association between ages, farming experience, training received, socio-economic status, cropping intensity, economic motivation, innovativeness, information sources, utilization, adoption, etc. However, there has been a fluctuating trend in maize production over the last decade which threatens household food security. Maize has yielded compelling success stories with the adoption of new technologies that has increased small holder maize production. The diffusion of new technologies in Africa has been more widespread for maize than for other food crops (Iken and Amusa, 2004).

This implies that technologies adoption can provide a basis for further increase in maize production. Farmers' efficiency in maize production resulting from technological innovations also has some food security implications. Food crises is more serious in sub-Saharan Africa where the attainment of food security is intrinsically linked with poor agricultural techniques which results in decrease in agricultural growth rate (Matata *et al*., 2010). Despite the economic importance of maize in Nigeria, it has not been produced to meet food and industrial demand. This could be attributed to low productivity from maize farms attributable to non-adoption of improved technologies by farmers. Therefore, the study intends to evaluate the index of adoption of maize production technologies and the correlation with adoption cost and farm output. To this effect, the following research questions would be asked.

1. What is the adoption index of maize production technologies among the respondents?
2. What is the correlation between adoption cost, adoption index and farm output?

Methodology

Study Area

Toro Local Government Area (LGA) covers a total land area of 6932km^2 and a total population of 350,000 people, projected at 3% growth rate per annum to be 499,586 in 2018 (NBS, 2012). Toro local government is topographically hilly with altitude of 100m above sea level. It is located on longitude 9°N and 12°E and latitude 8°N and 11°E. It is in the Sudan Savannah zone of Nigeria with an average rainfall ranging between 830mm to 1,100mm annually starting from April to October, with average temperatures of 35°C for lowland and 31°C for highland areas respectively (NBS, 2012).

Sampling Techniques

A multistage sampling technique was employed to select maize farmers in the study area. At first stage, Toro Local Government Area was selected; due to the prevalence of smallholder maize farmers in the area. The next stage involves a purposive selection of the three district of the Local Government. The three districts selected were Toro, Lame and Jama'a. The third stage involves a simple random sampling of two villages from each district. In the last stage, from compiled lists of maize farmers, by the local enumerators and extension agents; 10% respondents from each village was selected which gave an overall sample size of 101 respondents.

Method of Data Collection

The data collected for this study was obtained from primary sources. The data for this research was collected through the use of well-structured questionnaires.

Analytical Techniques

Data for the study were analyzed using adoption index and multivariate correlation techniques.

Model Specification

Adoption index

The index of adoption of maize production technologies was measured using the adoption index. Adoption index was computed for individual farmer following Saka and Lawal (2009) whereby adoption index (Bi) is given by:

$B_i = \sum (R_i/R_T)$ ……………….. (1)

Where:
B_i = the adoption index of maize production technologies by i_{th} farmer.
R_i = number maize production technologies adopted by i_{th} farmer; and
R_T = Total number of maize production technologies available to the i_{th} farmer.
i = (1…………n)
For this study, adoption index of ≤0.39 indicates low adoption index, while index of ≥0.4 indicates high adoption index.
Some of the recommended maize production technologies available in the study area include: Adjustment in planting date; Planting method and seed varieties; Plant spacing and seed rate; Weed management; Harvesting technology; Fertilizer application and management; Pest management; Postharvest Processing techniques; Storage methods; Water management; and Disease control.
Multivariate Correlation Analysis
The correlation analysis was used to analyze the multivariate relationship between adoption cost (x), adoption index (y) and farm output (z), where multiple correlation coefficients (R, r) are defined in equation (1), following Gujarat (2004):
$Rz, xy = \sqrt{r^2_{xz} + r^2_{yz} - 2r_{xz} . r_{yz} . r_{xy} / 1 - r^2_{xy}}$…….. (1)
Rz, xy= multiple correlation coefficient between dependent and independent factors; z= dependent variable z; x= independent variable x; y= independent variable y; r^2= coefficient of determination; r^2_{xz} = coefficient of determination between x and z; r^2_{yz} = coefficient of determination between y and z; r^2_{xy} = coefficient of determination between x and y; r_{xz}= correlation coefficient between x and z; r_{yz}= correlation coefficient between y and z; and r_{xy}= correlation coefficient between x and y.
Decision Rule: The strength of relationships based on the correlation coefficient (r) is expressed as follows:
≥ +/-0.7 (strong linear relationship); +/- 0.4 - 0.69 (moderate linear relationship); and ≥ +/-0.39 (weak linear relationship).
Results and Discussion
Index of Adoption of Production Technology
Table 1: Distribution based on the Index of adoption of Production Technology

Adoption index	Frequency	Percentage (%)
Low adoption index	62	61.4
High adoption index	39	38.6

Source: Field survey, 2020.
The result in Table 1 reveals that most (61.4%) of the farmers have low adoption index of ≤0.39; while, 38.6% have high adoption index of ≥0.4. The respondents indicated that several technologies for improved maize production were available in the area. However, the index of adoption of these technologies is very low and not satisfactory. This trend is responsible for the existing low farm productivity for this crop in the area as observed in previous studies (Maiangwa, 2008). It is well known that in sub-Saharan Africa low agricultural productivity by small scale farmers have been attributed to poor adoption of improved agricultural technologies. Therefore,

identification of factors hindering adoption/uptake of improved agricultural technologies becomes very critical in the area (Bonabana- Wabbi, 2002).

Correlation of Multivariate Factors (Output, Adoption Cost and Adoption index)

Table 2: Correlation Coefficient Matrix

Factors	Farm Output (z)	Adoption cost (x)	Adoption index (y)
Farm Output (z)	1.00		
Adoption Cost (x)	-0.65*	1.00	
Adoption index (y)	0.52*	-0.58*	1.00

Source: Field Survey, 2020; *Correlation coefficient (r) is significant at 5% level (2-tailed).

Table 2 revealed that the result of the correlation analysis was significant at 5% level of probability. This suggests that a significant correlation between multivariate factors exists. The estimated correlation coefficient between x and z (r_{xz}) was -0.65; which suggests a moderate and inverse linear relationship between the factors. This implies that as adoption cost increases technology adoption decreases and consequently overall farm output declines. The estimated correlation coefficient between y and z (r_{yz}) was 0.52 which suggests a moderate linear relationship between the factors. This implies that as the adoption index increases the level of farm productivity tend to also increase. The estimated correlation coefficient between x and y (r_{xy}) was -0.58, which suggests a moderate and inverse linear relationship between the factors. This implies that as adoption cost increases the index of adoption of maize production technologies among the farmer's declines. The implication of these findings is that adoption of production technologies tends to increase the level of farm productivity in the study area and hence improve agricultural sustainability. Furthermore, the cost of production practices determines farm level adoption. Thus, this result corroborates with the findings of Yasin (2003) who also evaluated the relationship among similar multivariate factors.

Conclusion and Recommendations

This study analyzed the adoption index of maize production technologies and the correlation with adoption cost and farm output in smallholder farming systems in Toro, Bauchi State, Nigeria. The findings revealed that there were several maize production technologies available in the study area; however adoption of these technologies was relatively low. Furthermore, a significant linear relationship between the multivariate factors (farm output, adoption cost and adoption index) exists; thus, positive correlates facilitate agricultural sustainability. Based on the findings of this study, the following recommendations are made: Formulation and implementation of policies that will subsidize the cost of maize production technologies; improve farmer's access to production technologies and improve farmers' access to agricultural credit will enable them adopt more options of production technologies. Further, improving extension activities by establishing agro service centers in the area will also facilitate technology transfer.

References

Abebaw D. and Abelay, K. (2001). Factors influencing adoption of high yielding maize varieties in Southeastern Ethiopia: An application of logit analysis. *Quarterly, Journal of*

International Agriculture, 40 (2): 149-167.

Matata, P.Z., Ajayi, O.C., Odoul, P.A., O.C and Agumya, A. (2010). Socio-economic factors influencing adoption of improved fallow practices among small holder farms in Western Tanzania. *African Journal of Agricultural Research*, 5(8): 818-823.

Ali-Olubwanda A.M, Odero-Wanga D, Kathuri N.J and Shigova W.A. (2010). Adoption of improved maize production practices among small scale farmers in agricultural reform era: The case of western province of Kenya. *Journal of International Agricultural & Extension Education*, 17(1):21-30

Bawa D.B and Ani A.O. (2014). Analysis of adoption of improved maize production technology among farmers in Southern Borno, Nigeria. *Research on Humanities and Social Science*, 4(2):43-54

Bonabana-Wabbi, J. (2002). Assessing Factors Affecting Adoption of Agricultural Technologies: The Case of Integrated Pest Management (IPM*);* In Kumi District, Eastern Uganda. MSc (Agricultural and Applied Economics). Thesis Submitted to the Faculty of the Virginia Polytechnic Institute and State University, Blacksburg, Virginia, USA, 146pp.

Gujarat D.N. (2004). *Basic Econometrics*, fourth edition. Tata McGraw-Hill Publishing Company Limited, New Delhi, India.

Idrisa Y.L, Shehu H, and Ngandu M.B. (2012). Effect of adoption of improved maize seed on household food security in Gwoza EGA of Borno State, Nigeria. *Global Journal*, 12 (5): 36-45.

Iken J.E and Amusa N.A. (2004). Maize research and production in Nigeria. *African Journal of Biotechnology*. 3 (2): 56-64.

Komolafe S.E, Adeseji G.B and Ajibola B.O. (2010). Determination of adoption of improved crop practices among women farmers in Ekiti East LGA of Ekiti State, Nigeria. *Journal of Agricultural Research*, 5(2):22-33

Maiangwa N.G. (2008). Adoption of mixed cropping by farmers in the North Western Zone of Nigeria, *Global Journal of Agricultural Research*, 3(1): 25-30

National Bureau of Statistics (NBS) (2012). *Socio-economic Survey on Nigeria*. First Quarter Report, NBS, Abuja

National Agricultural Extension Research and Liaison Services (NAERLS) and Federal Department of Agricultural Extension (FDAE) (2014). *Agricultural Performance Survey of 2014.Wet season in Nigeria*, Executive Summary Report. pp.23

Ouma J.O, Murithi M.F, Mwangi W, Macharia H.G and Gronte H.D. (2002). Adoption of maize seed and fertilizer technologies in Embu district, Kenya: Diffusion of innovation, fifth edition, New York, The Free Press.

Saka, J.O and Lawal, B.O. (2009). Determinants of adoption and productivity of improved rice varieties
in South-western Nigeria. *African Journal of Biotechnology*, 8: 23-32.

Yasin, G., Aslam, M., Parvez, L. and Naz, S. (2003). Socioeconomic Correlates of Pesticide Usage: The Case of Citrus Farmers. *Journal of Research (Science), Bahauddin Zakariya University, Multan, Pakistan*, 14(1): 43-48.

2 RURAL WOMEN AND AGRO – PROCESSING: A CASE STUDY OF RURAL WOMEN PARTICIPATION IN GROUNDNUT PROCESSING IN KATSINA STATE

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Abstract
The study was conducted in three agricultural zones (Ajiwa, Dutsin-ma and Funtua) of Katsina State and focused on the participation of women in groundnut processing. A multistage sampling technique was adopted to collect data from two hundred and ninety-seven (297) women involved in agro-processing activities. Descriptive statistics and analysis of variance were used for data analysis. Findings of the study revealed that majority of agricultural processing activities in the area were carried out by women and children with 55.56 % of the women involved been educated the mean age of women groundnut processors in the area is 37 years with a mean household size of 7 members. The study shows that women accounts for 85.86% of groundnut processors with a mean value of 28.73 engaged in the business. It further revealed that 68.01% of women groundnut processors in the area were married with a mean value of 22.44. Years of experience in groundnut processing among the participating women varies but the mean years of experience of women groundnut processors in the area is 6 years. The results from the analysis of variance conducted show that $P > 0.05$ which indicate that age and educational level influence women participation in groundnut processing business. The F - ratio for both age and education level are very high ($F_C > F_T$) at 5% level of significance indicating a relation with participation of women in groundnut processing venture. Based on findings of the study, it is recommended that simple and affordable groundnut processing technology should be made available by relevant agricultural mechanization agencies to women in the rural areas for increased productivity and higher income.

Key words: Agro-processing, groundnut, participation, processing, women,

Introduction

Agro – processing can be traced back to pre – historic period when the early man learns how to dry under the natural sun the fruits and flesh as food materials. It is an important component of agribusiness development where agricultural products pass through some degree of transformation after harvesting to final use. Agro–processing is a set of techno economic activities carried out on an agricultural product to make it more useful as food, feed, fiber, fuel or industrial raw materials (Tamil Nadu, (2015). Aboki (2015) defined processing "as any activity that maintained or raise the quality or alters the physical and/or chemical characteristics of a product or material". It is generally a value addition that is being carried out in order to produce a new product in a more acceptable form of improved quality and increased shelf life. Adesope, *et al*., (2010) pointed out that agro–processing is carried out to reduce spoilage, waste and other losses in quality and quantity of agricultural products between the time of harvesting and time of marketing to consumption.

Food processing is an ancient activity that begins with home cooking to industrial processing with increased emphasis on safety and nutritional quality of processed products. The important characteristics defining food quality such as appearance, texture, taste and nutritional content are significantly affected by processing method and techniques used. Food processing is therefore, becoming increasingly challenging and diverse to provide food materials with certain characteristics to meet consumer's requirements for acceptability and usage (Adesope *et al.*, 2010). The major agricultural products from crops that are processed into food materials and consumed in the rural communities in Nigeria include cowpea, groundnut, soybean, cassava, maize and wheat while agricultural products from animals include milk, fish, egg and flesh. Food processing can be simple and easy or complicated and the factors that affect the processing operation include the following:

i. The agricultural products to be processed.
ii. Technology employed for the processing.
iii. The level of processing (output) required.
iv. Skill of the processor.

Groundnut production is dominated by men especially in the northern part of Nigeria while more than 75% of groundnut is undertaken by women and children (Muhammad – Lawal, Animashun and Towujo, 2012). According to Food and Agricultural Organization (FAO) (2011), groundnut processing activities in the rural areas are at small scale level requiring low initial capital outlay, hence can be undertaken by women. Groundnut processing venture by the rural women plays significant roles toward development of rural economy as pointed out by Aliyu (2015). These include improve local income of the rural women, increased rural women empowerment, provide supplement in the family diet, provide high quality livestock feed and improve financial status.

Women in the rural areas are the major small-scale processors of groundnut in Katsina State to provide local informal economic contribution to household welfare. They have a very high regard for groundnut processing business because of its contribution towards the development of the rural economy. However, according to Adesope *et al.* (2010), there are none or limited knowledge on the contributions of rural women towards proliferation of rural – based agro- processing industry. It is therefore of paramount importance to understand the level of participation of the rural women in groundnut processing.

Objectives of the Research

The specific objectives of the research are to:

1. examine the socio-economic characteristics of rural women groundnut processors;
2. determine the level of participation of rural women in groundnut processing business and
3. determine if any relationship existed among the age, educational level and women participation in groundnut processing enterprise.

Research Hypothesis

1. There is no significant relationship between age of women and their participation in groundnut processing business.
2. There is no significant relationship between educational level of women and their participation in groundnut processing business.

Materials and Methods

Description of Katsina State

Katsina State is located on coordinates 12.15º N, 7.30º E in Northern Nigeria (MOI, 2020). It occupies a total land area of 24,192 square kilometers predominantly inhabited by Hausa and Fulani with a population of 7,831,300 (NPC, 2016). Katsina State boarders Kaduna State to the south, Jigawa and Kano States to the east, Zamfara State to the west and the Niger republic to the north. The State has an average annual rainfall ranging between 550 mm to 600 mm. High temperature of 32ºC – 33ºC is experienced from the month of March to April and low temperatures of 19ºC – 22ºC from December to February (Nigerian Meteorological Agency NIMET, 2018). According to International Fund for Agricultural Development (IFAD) (2010), the major agricultural crops produced include millet, sorghum, groundnut, maize, cotton and cowpeas. In the year 2019, a total land area of 105,000 hectares was devoted to groundnut production in Katsina State with a production of more than 56,000 metric tons (Tsedeke, 2020).

Sampling Procedure and Sample Size

A multistage sampling technique was employed in the research. In the first stage, three agricultural zones (Zone I - Ajiwa, Zone II - Dutsin-ma and Zone III - Funtua) of the State were chosen. In the second stage, two Local Government Areas (LGAs)from each zone were purposively selected based on the predominance of women groundnut processors, giving a total of six LGAs for the study. The selected LGAs are Katsina and Mani from Zone I, Bakori and Danja from Zone II, Dutsin-ma and Kankia from Zone III. In the last stage, random sampling technique was adopted to select two villages from each of the LGAs. The villages selected are Shinkafi and Dandagoro from Katsina LGA, Muduru and Tsagem from Mani LGA, Guga and Tsiga from Bakori LGA, Tandama and Dabai from Danja LGA, Karofi and Kuki from Dutsin-ma LGA, Kafinsoli and Rimaye from Kankia LGA. Random selection was also used select twenty-five women groundnut processors from all the villages to have a sample size of 300 rural women groundnut processors.

Data Collection Methods

A structured questionnaire was used to collect information on the socio-economic characteristics of the respondents, type of agro-processing under taken and years of experience in groundnut processing business.

Analytical Tool

Data were subjected to descriptive statistical analysis (percentages, frequency and mean). Inferential statistical analysis was also conducted. The relationship between age, educational level and women participation in groundnut processing were tested using analysis of variance at 5% level of significance.

Results and Discussion

Distribution of socio-economic characteristics of women participating in groundnut processing from the three agricultural zones of Katsina State is presented in Table1. The results in Table 1 show that majority of women involved in groundnut processing business were within the age of 36 years to 45 years (78.45%), they were married 68.01% with household size of between 6 members to 10 members (35.69%). This result is in accordance with the report of Mohammed and Olaleye (2015) which reveals that 48% of women groundnut processors had a household size of 1 to 10 members. It implies that more youth women participate in groundnut processing business than elderly women. This may be due to the hard work involved in groundnut processing activities.

The result clearly indicates that women were involved in agricultural processing activities with more women participating in groundnut processing (85.86%). This is in line with report of Maigida (2012) which states that women groundnut processors contributed significantly in agricultural processing activities. From the result, the women groundnut processors had either in formal or formal education. It reveals that only women with in formal education (44.44%), primary (39.73%) and post primary (15.83%) education level participate more in groundnut processing venture. This result supported the report of Adesope *et al.* (2010) that revealed women of higher education were less involved in agro-processing than women with lower level of education.

Table 1: Socio-economic characteristics of women groundnut processors in the study area

Socio economic Characteristics	Frequency	Percentage (%)	Mean ($\bar{x}$)
Marital status			
Single	*71*	23.91	7.89
Married			22.44
	202	68.01	
Divorced			2.67
Age	*24*	8.08	
15 – 25 yrs			
26 – 35 yrs	*16*	5.39	37
36 – 45 yrs	*33*	11.11	
Above 45yrs	*233*	78.45	
House hold size	*15*	5.05	
2 – 5 members			7
6 – 10 members	*99*	33.33	
Above 10 members	*106*	35.69	
Educational level	*92*	30.98	14.67
Non formal education			13.11
Primary education	*132*	44.44	5.22
Post primary education	*118*	39.73	
Tertiary education	*47*	15.83	
Type of agro – processing	-		3.44
Grain threshing/ milling			28.33
Groundnut processing	*31*	10.44	-
Garri processing	*255*	85.86	1.22
Other agro-processing	-	-	
Years of experience	*11*	3.7	
processing			6
2 – 5 yrs		51.18	
6 – 10 yrs	*152*	43.10	
Above 10 yrs	*128*	5.72	
	17		

Source: Field work (2022)

The relationship between age, education level and participation of women in groundnut processing in the three agricultural zones of Katsina state is presented in Table 2.

Table 2: Analysis on age, education level and women participation in groundnut processing

Parameters	Variables	
	Age	Education level
Sample size N	297	297
F ratio (5%)	151.97*	77.98*
Coefficient of variation R^2	0.71	0.56

Source: ANOVA *Significant at 5% level

Result from the analysis of variance on Table 2 show that age and educational level of the women groundnut processors influence their participation in groundnut processing business. From result of the study in Table 2, $P > 0.05$, the F -ratio for both age and education level are very high ($F_C > F_T$) at 5% level of significance indicating a relation with participation of women in groundnut processing venture.

Conclusions

Agro-processing has become an important agribusiness among rural women with a very high regard to groundnut processing business. The rural women engaged in different agro-processing venture in order to support their families. The study reveals that youth among women participate more in groundnut processing than the elderly women due to the hard work involved in groundnut processing activities. It also shows that women with informal and lower level of education dominate groundnut processing business in the area while women of higher level of education do not participate in groundnut processing or any other agro-processing activities. The study indicates a significant relationship between age, education level of the rural women and their participation in groundnut processing venture.

Aboki, P. M. (2015). Traditional and Modern Groundnut Processing and Marketing in Northern Nigeria, *PhD thesis*, submitted to School of Post graduate studies, University of Nigeria, Nsukka

Adesope, O. M., Nwakwasi, R. H., Mathew – Njoku, E. C. & Chikaire, J. (2010). Extent of Rural Women's Involvement in the Agro-processing Enterprise of the National Special Programme for Food Security in Imo State, *Report and Opinion*, 2(7): 69 - 73

Aliyu, N. (2015). The Role of Women in Groundnut Value Chain in Kano State Nigeria, *MSc thesis*, submitted to the School of Postgraduate Studies, Ahmadu Bello University Zaria

Food and Agricultural Organisation FAO (2011). Processing and Preservation: Junior Farmer Field and Life, *School Facilitator's Guide No. 8 (15)*, Rome, accessed on 28th June, 2022 from http://www.cpdbangaladesh.org/publication/cpdiri

International Fund for Agricultural Development IFAD (2010). *Annual technical report*, Katsina State Coordinating Office, Katsina State 2010 Report

Maiguda, D. N. (2012). Challenges Affecting the Involvement of Women Groundnut Processors in Women in Agriculture Programme (WIA) in Kano State, *Journal of Agricultural Extension*, 2(7):43 – 51

Muhammad, U. and Olaleye, R. (2015). An Assessment of Demographic Characteristics of

Women Involvement on the Improved Methods of Groundnut Processing in Three Local Government Areas of Niger State, Nigeria, *American Journal of Experimental Agriculture*, 6(5): 326 – 332

Ministry of Information MOI Katsina State, (2020). *Yearly News Bulleting*, accessed on 20th August, 2021 from http://www.wikipedia.org

Muhammad – Lawal, A. Animashun, J. O. & Towuju, A. S (2012). Economics of Small Scale Agro-enterprise in Nigeria: A Case Study of Groundnut Processing Among Rural Women in Kwara State, *Journal of Sustainable Development in Africa*, 14(5): 54 – 64

Nigerian Metrological Agency NIMET (2018). *Annual Climate Review Bulletin*, Katsina State Office, Katsina, Nigeria

National Population Commission NPC (2016). National Census and House Survey, *National Population Commission Report*, Headquarters, Abuja, Nigeria

Tamil, N. (2015).Tamil Nadu Agricultural University, Coimbatore, accessed on 28th June, 2022 from http://www.agrritech.tnan.ac,in/

Tsedeke, A. (2020).Groundnut trends in 10 top producing states of Nigeria, accessed on 28th June, 2022 from http://www.nigeriastat.gov.nd

3 PROFITABILITY OF DRIP IRRIGATED MAIZE PRODUCTION FOR IMPROVED FOOD SECURITY IN MAIDUGURI SEMI-ARID REGION OF BORNO STATE, NIGERIA

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Abstract
In the arid and semi-arid areas of Nigeria, water is the major constraint in crop production. Farmers in the region use furrow irrigation method and fixed irrigation interval schedule for maize production. The irrigation method and schedule used by the farmers has become unsustainable due to low yield, low water use efficiency, low quality of maize kernels and low net farm income. Thus, there is a growing gap between the demand for maize and its production to meet the food requirement for the growing population in the region. And one of the existing Climate Smart Agriculture (CSA) Practices in recent times is 'Water smart' which included drip irrigation. The aim of this study was to determine profitability of irrigated maize production in semi-arid environment of Nigeria. Two field experiments were conducted in the 2014 and 2015 seasons at the Teaching and Research Farm of Ramat Polytechnic Maiduguri, Borno State which is in the semi-arid region of Northern Nigeria. The experimental design was a randomized complete block design with irrigation scheduling methods at three levels namely fixed irrigation interval, scheduling using tensiometer at trigger level of 30 centibar and pan evaporation method. The profitability analysis result revealed that, the combination of drip irrigation and tensiometer schedule at trigger level of 30 centibar had a net farm income and benefit cost ratio of $695.2 and 3.20, respectively. It is recommended that farmers in the semi-arid region of Nigeria should use gravity drip irrigation system with irrigation interval of 4 days for the replenishment of soil moisture to the desired level for optimum maize production to meet the increasing demand for food for the growing population based on its proven performance and economic viability as shown in this study.
Keywords: Drip, Irrigation, profitability, Semi-Arid

INTRODUCTION

Irrigation agriculture is crucial to the economy, it is too important to be marginalized as it is vital for world food security (Ayinde, 2016). This is particularly so due to water scarcity because of the impact of climate change and the increasing global demand for water from many sectors including agriculture, especially in semi-arid regions where irrigation is the only alternative for crop production to meet the demand for food for the rapidly growing population (Bashir, 2018). Irrigation has made higher and more reliable yield possible as crops can be planted more than once in a year within the topics, apart from bigger and reliable yield as against yearly cultivation, which is often at the mercy of seasonal rainfall (Worlf, 1995). It has also been seen that drip irrigation systems have increased farmers' resilience to climate-induced water scarcity (FAO, 2021). One of the existing Climate Smart Agriculture (CSA) Practices is 'Water smart.' This is inclusive of Rainwater harvesting, drip irrigation, less water requiring crops, re-use of wastewater shifting of crops, use of flood and drought resistant varieties, mulching etc. (Sharma, 2016). Globally one type of technology that may contribute to the improvement of water supply management and the associated food crisis is drip irrigation (Bukar et al.,2019)

Agricultural production and activities have a problem when either too much or too little water is available in the root zone. A shortage of water can be compensated by irrigation. Surface irrigation is related to a potentially heterogeneous water supply to crops and water losses in terms of water run-off, deep percolation, evaporation, and wind-drift. In contrast, drip irrigation systems can significantly reduce water losses because only the immediate root zone of each plant is wetted. In Bulgaria, Koumanov *et al* (2006) showed that on raspberry plantations water savings between 4 and 17 per cent may be obtained through this method without significant reductions in yield. While flood irrigation was suitable in many places in Asia during the 20th century, but water availability and cost factors could make small-scale, low-cost, drip irrigation suitable for places in Africa in the 21st (Chigerwe, Manjengwa, et al., 2004).

In the arid and semi-arid areas of Nigeria, water is the major constraint in crop production. Rainfall is extremely irregular, to the extent that the amount and distribution in space and time had not been ideal to optimally support crop production (Dibal *et al*., 2006).
Farmers in the region use furrow irrigation method and fixed irrigation interval (7 days) schedule for maize production. The irrigation method and schedule used by the farmers has become unsustainable due to low yield, low water use efficiency, low quality of maize kernels and low net farm income (Bashir, 2018). Thus, there is a growing gap between the demand for maize and its production to meet the food requirement for the growing population in the region. The aim of this study was to determine profitability of drip irrigation method for maize production for semi-arid environment of Nigeria.
Maize accounts for about 43% of calorie intake in Nigeria (Alabi and Esobhawan, 2006). Apart from being a food crop, maize has equally become a commercial crop on which many industries depend on for raw materials (Abd El-Waheed and Ali, 2012). Maize contributes to about 80% of poultry feeds and this has significant effect on the protein intake in Nigeria (IITA, 2008). Therefore, maize can be considered very vital to the economic growth of the nation through its contribution to food security and poverty alleviation. Addressing the challenges of poverty and food insecurity calls for boosting agricultural production in Nigeria (Xie et al., 2017). Irrigation that had the highest contribution to increasing the global food production is the only alternative solution to this problem (Adeniji, 2002). Currently, crop production in Nigeria is rain fed; the irrigated agriculture accounts for only 1% of cultivated area in the country (FAO AQUASTAT, 2017). This rain fed agriculture makes crop production in Nigeria vulnerable to climatic variability, both intra-annually and inter-annually.
Irrigation has also greatly helped in stabilizing food production and prices over the years (Rosegrant *et al*., 2002). Today irrigated agriculture continues to make civilization less dependent on the vagaries of climate for food and fiber requirement to sustain life.
The general objective of this study is to examine the economics of irrigated maize production in Maiduguri, Borno State, Nigeria.
Specific objectives are to:
i. determine the costs associated with maize production using drip irrigation method under different irrigation schedules
ii. determine the profitability of maize production using drip irrigation method under different irrigation schedules

MATERIALS AND METHODS
Study Area

Field experiments were conducted at the Teaching and Research Farm of Ramat Polytechnic Maiduguri, Borno State which is situated at latitudes 11° 46'18''N to 11° 53' 21''N and longitudes 13° 03' 23''E to 13° 14' 19''E in the semi-arid region of Northern Nigeria as shown in Figure 1. Maiduguri lies within the Lake Chad Basin formation and is about 355m above sea level. The climate of area is semi-arid or tropical grasslands vegetation which is known for its dryness. The area has a long dry season of 6 to 7 months spanning from November to Mach and a short-wet season that last for about four months (July to October). The area has high temperatures which ranges from 20-43ºC with an average annual precipitation of about 640mm. The hottest months are usually April and May, while the cold and the dry periods of harmattan are from November to January.

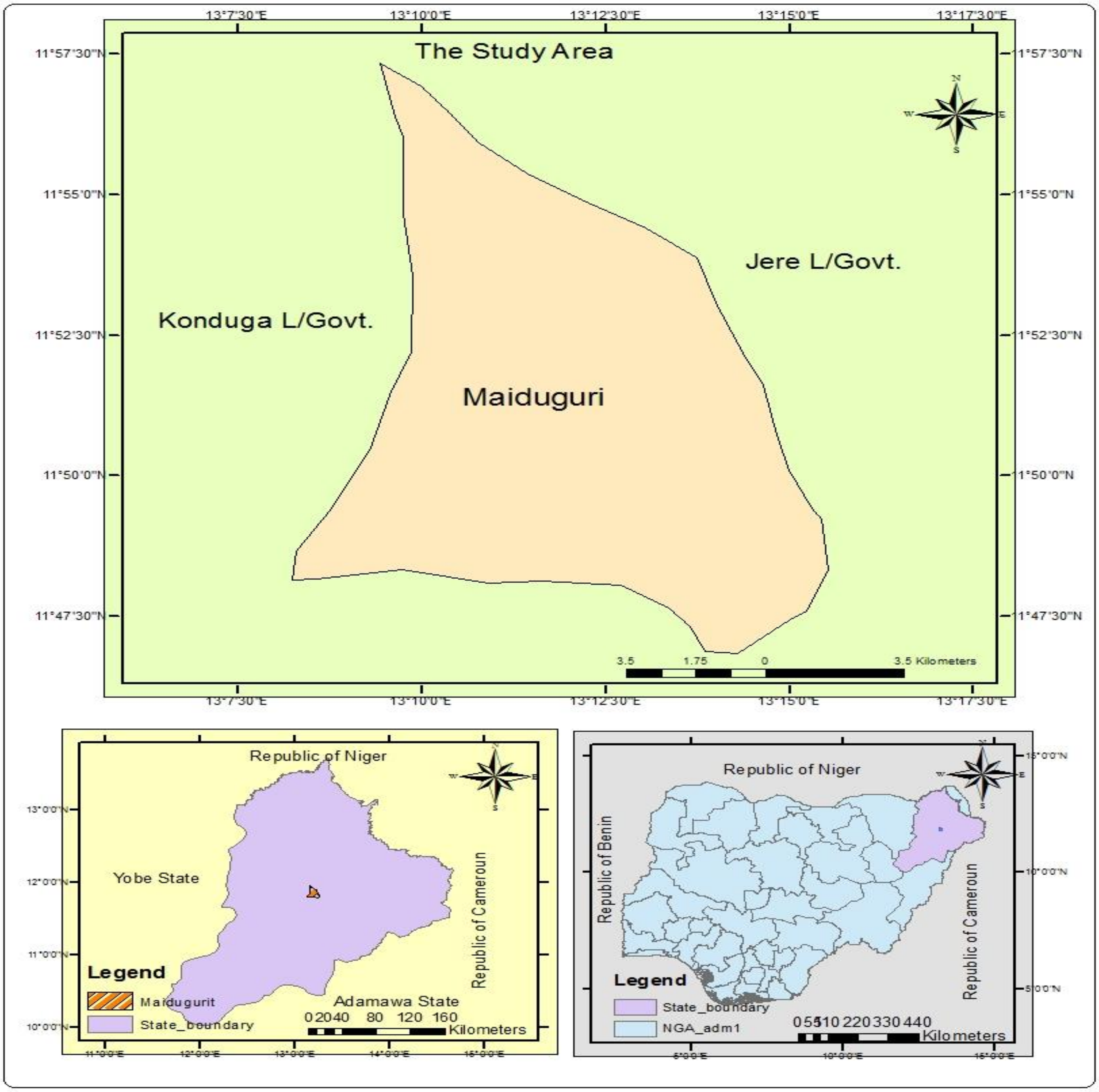

Figure 1: Map of the study area

Drip Irrigation System layout

The system of irrigation used is gravity drip irrigation system. The system consists of a reservoir, mainline, laterals and drippers which were all made from plastic materials. Each treatment had three (3) laterals which were laid on ridges at a spacing of 0.75m. The internal diameters of the mainline and laterals were 19.1mm and 12.7mm, respectively. The drippers were spaced 0.5m along the laterals as shown in Figures 2. The spacing of 0.75m and 0.5m were chosen based on the recommended spacing for growing maize.

Experimental Design and Treatment

The experimental design was a randomized complete block design with irrigation scheduling methods at three levels namely fixed irrigation interval, scheduling using tensiometer at trigger level of 30 centibar and pan evaporation method.

Irrigation Schedule

The exact amount of water required by the maize crop was applied using different irrigation intervals based on the use of tensiometer, pan evaporation and fixed irrigation interval. Irrigation was conducted in the plots monitored by the tensiometer whenever the trigger level of 30cb is reached. The choice of 30cb as the trigger level was based on the research findings of Rhodes and Stanley (1973) and Rivera-Hemendez *et al.* (2010) where both reported optimum yield and water use efficiency of maize at 30cb.

The evaporation pan used was the standard class A evaporation pan made from galvanized iron and is 120.5cm in diameter and 25 cm deep filled with water to a depth of 20cm. The crops were irrigated based on the ratio of irrigation amount (IW) to cumulative pan evaporation (CPE) that is IW/CPE ratio. Daily records of pan evaporation data were taken from the class A evaporation pan located in the research farm and irrigation was conducted at 1.0 IW/CPE ratio for optimum yield. The choice of the ratio of IW/CPE of 1 for scheduling maize in this work was based on the findings of earlier research which shows higher yield and water use efficiency values when irrigation was scheduled at the ratio of IW/CPE equals to 1 (Simsek *etal*., 2013).

A fixed irrigation interval of 7 days was used for irrigating the maize crop under all the different irrigation systems based on the traditional irrigation cycle used by the farmers

Determining the Performance of the Farm Enterprises

The net farm income was calculated using equation 1 used by Haruna *et.al*. (2010)

NFI=TR-TC.. 1

Where:

NFI = net farm income from production per hectare.

TR = total revenue/returns from production per hectare.

TC = total costs of production per hectare.

Benefit cost ratio (BCR)

The benefit cost ratio (BCR) which is the ratio of the present value of benefit and the present value of cost was determined using equation 2:

BCR=Benefit/Cost.. 2

These were performed by showing all costs incurred and the total revenue obtained from the production based on the drip irrigation and schedules used in the study. All costs were classified as either fixed or variable cost. Costs that were incurred due to land hiring, land preparation, seed, fertilizer, water used, fuel, rented pump, rented water reservoir, water application, planting, fertilizer application, weeding, harvesting, and threshing were classified as a variable cost. While costs incurred from the drip irrigation components were classified as a fixed cost. The variable cost and fixed cost were summed up to arrive at the total production cost for the research. The total revenue was obtained by quantifying the yield in monetary terms. The two costs-production cost and selling price (total revenue) were compared to evaluate the economic viability of different irrigation methods and techniques for maize production. The net farm income, benefit cost ratio and were determined using the procedures outlined by Rao (1994), Brennan (2008) and Srivastava (2012) as shown in equations 1 and 2, respectively.

Costs of Production

Costs of production are classified into fixed costs and variable costs. To facilitative the calculation of net farm income and benefit cost ratio which were used to determine the profitability and economic viability.

The different cost items were identified, quantified and the amount involved in their use in the maize production were summed up and subtracted from the total returns. The following are the different costs in the maize cultivation.

Land Hiring, Land Preparation, Seed Cost, Cost of Fertilizer, Cost of Fuel, rented pump, Water used Cost, Rented Water Reservoir Cost, and Labour Cost

RESULTS AND DISCUSSION

Economic analysis of maize production under drip irrigation methods and schedules

The process of choosing the most economically viable combination of schedule is one of the most important considerations in the development of irrigated agriculture especially in arid and semi-arid areas.

The results of the total cost involved under drip irrigation methods and schedules are presented in Table 1. The result shows that the total cost of production varied from 296.45 to 316.04

The fixed costs accounted for 19.07 to 20.33% of the total cost of production. The variable costs per hectare and schedules were 236.18 to 255.77 $/ha.

The variable costs were higher in pan and tensiometer irrigation techniques with shorter irrigation interval (4days) which resulted in higher cost of fuel and water application compared to the fixed irrigation interval of 7 days. The total variable cost contributed 79.67% to 80.91% to the total cost. Fertilizer and water application costs accounted for 40.3 to 61.00% of the total variable cost.

Table 1 Total cost involved under drip irrigation methods and schedules

Variable inputs cost (VC)	Fixed	Tensiometer	IW/CPE
Land hiring	10.71(4.53)	10.71(4.19)	10.71(4.19)
Land preparation	17.86(7.56)	17.86(6.98)	17.86(6.98)
Seed	4.76(2.02)	4.76(1.86)	4.76(1.86)
Fertilizer	144.05(60.1)	144.05(56.3)	144.05(56.3)
Water used	3.75(1.59)	6.67(2.61)	6.67(2.61)
Rented water reservoir	11.9	11.9	11.9
Water application	21.43(9.07)	38.1(14.90)	38.1(14.90)
Fertilizer application	8.93(3.78)	8.93(3.49)	8.93(3.49)
Weeding	4.46(1.89)	4.46(1.90)	4.46(1.74)
Harvesting	4.76(2.02)	4.76(1.86)	4.76(1.86)
Threshing	3.57(1.51)	3.57(1.40)	3.57(1.40)
Sub Total	236.18	255.77	255.77
Drip components	60.27	60.27	60.27
Sub Total	60.27	60.27	60.27
Total Cost	296.45	316.04	316.04

Source: Field experimental data 2014/2015

Land hiring, preparation, seeds, water used, weeding, harvesting, and threshing contributed 5 to 7.56%, 3 to 4.53%, 1.33 to 2.02%, 1.54 to 3.40%, 1.25 to 1.90%, 1.33 to 2.02% and 1 to 1.51% of the total variable cost, respectively. Fuel and rented pump accounted for 4.13 to 21.33% and 2.05 to 6.67% of the total variable cost, respectively. A substantial proportion of the total variable cost was spent on fertilizer and water application. The total revenue ranged from 468.3 to 1011.2 as shown in Table 2.

The total revenue amounted to $1011.2 as shown in Table 1. This could be due to the higher drip water application efficiency of 80% which resulted in improved yield production. The tensiometer at trigger level of 30 centibar and the ratio of irrigation amount to cumulative pan evaporation techniques also gave higher total revenue when compared with the fixed irrigation interval (7 days).

Table 2: Net farm income for maize production

	Fixed	Tensiometer	IW/CPE
Yield (kg)	2431.3	5056.0	5049.3
Unit price/100kg	20	20	20
Total revenue	468.3	1011.2	1009.8
Total Cost	296.45	316.04	316.04
Net farm income	171.8	695.2	693.8
Benefit cost ratio	1.64	3.2	3.1

The result further revealed a net farm income and benefit cost ratio of $695.2 and 3.2 The result of this study is similar to the findings of Bostch *et al*. (1992), Hengler (1997), O'Brein *et al*. (1998) and Namara *et al*. (2007).

Conclusion

Based on the research conducted to determine the proper irrigation method and schedule for maize production in the semi-arid environment of Nigeria, the following conclusions can be drawn:

1. The combination of drip irrigation with tensiometer schedule was found to be the most profitable irrigation method and schedule for maize production with higher net farm income of $695.2 and benefit cost ratio of 3.2 compared to the net farm incomes of $693.8 and benefit cost ratios of 3.1 obtained using drip and pan evaporation schedule and $171.8 and 1.64 from the drip and fixed irrigation interval schedule.

Recommendations

Based on the findings of this study, the following recommendations are made:

1. The use of gravity drip irrigation system with tensiometer that resulted in irrigation interval of 4 days is recommended for farmers in this region for the replenishment of soil moisture to the desired level for optimum maize production to meet the increasing demand for food for the growing population based on its proven performance and economic viability as shown in this study.
2. Government should assist farmers to acquire drip irrigation kids to intensify its usage for optimum maize production in the region.

References

Abd El-Wahed, M. H. and Ali, E. A. (2012). Effect of irrigation systems amounts of irrigation water and mulching on corn yield, water use efficiency and net profit. Agricultural Water Management, 120, 64–71.

Adeniji, F. A. (2002). Operation and maintenance in capacity Utilization for sustainable development in Contemporary Nigeria. University of Maiduguri Faculty of Engineering Seminar Series. 2(1), 1-15

Alabi, R. A. and Esobhawan, A. O. (2006). Relative economic value of maize-okra intercrops in Rainforest zone, Nigeria. Journal of Central European Agriculture, 7(3), 433-438.

Ayinde Alani Ezekiel (2016) Economic Analysis of Maize Production Among Irrigation Farmers in Orire Local Government Area, Oyo State, Nigeria Sociology Study, March 2016, Vol. 6, No. 3, 186-195 doi: 10.17265/2159-5526/2016.03.004

Bashir, A.U. (2018) Determining the Proper Irrigation Method and Schedule in Maize Production for Semi-Arid Environment of Nigeria Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of

Philosophy 243pp.
Bosch, D. J., Powell, N. L., & Wright, F. S. (1992). An economic comparison of subsurface micro irrigation with center pivot sprinkler irrigation. Journal of Production Agriculture, 5(4), 431-437.
Brennan, D. (2008). Factors affecting the economic benefits of sprinkler uniformity and their implications for irrigation water use. Irrigation Science, 26(2), 109-119.
Bukar M., Arku A.Y., Dibal J.M., Bunu M. and Mustapha B. (2019). Influence of Flow Rate and Hydraulic Head on Performance Evaluation of Micro -Drip Irrigation using Tomato. (Lycopersicon esculentum) in Maiduguri semi-arid region of Borno State. *National Innovation and Research Academia* International Journal of Agribusiness and Agricultural Sciences ISSN: 2713-4670. Volume 7, Issue 1. Pages 07- 17. June, 2019.
Chigerwe, J., Manjengwa, N., et al. (2004). Low head drip irrigation kits and treadle pumps for smallholder farmers in Zimbabwe. Physics and Chemistry of the Earth, 1049–1059.
Dibal, J. M., Dauda, A. and Umara, B. (2006). Irrigation and Society. A Review, University of Maiduguri Faculty of Engineering Seminar Series 4(1): 52-61.
FAO AQUASTAT, (2017). Regional Report-Nigeria (http://www.fao.org/nr/water/aquastat/countries regions/nga/index.stm, last Access: 8/10/2017).
FAO. (2021). Climate Smart Agriculture case studies 2021-projects from around the world Rome https://doi.org/10.4060/c659en
Haruna, U, Garba, M., Nasiru, M. and Sani, M. H. (2010). Economics of Sweet Potato Production in Toro Local Government Area of Bauchi State, Nigeria. Proceedings of 11th Annual National Conference of National Association of Agricultural Economists (NAAE), Federal University of Technology, Minna. 30th – 3rd December.
Henggeler, J. C. (1997). Irrigation economics of drip-irrigated cotton under deficit irrigation. In Proc. Irrigation Association Technical Association, 125-132.
IITA. (2008). Maize Production in Nigeria. International Institute for Tropical Agriculture, Bulletin No 3, 25-28.
Koumanov, K, Kolev, K, Rankova, Z, Milusheva, S, Rusalimov, Z and Tsareva, I (2006) Regulated deficit drip irrigation and water use efficiency of a raspeberry (Rubus idaeus L.) primocane-fruiting cultivar. Presented at the 7th international micro-irrigation congress, Sept 10-16 2006, PWTC, Kuala Lumpur.
Namara, R. E., Nagar, R. K., and Upadhyay, B. (2007). Economics, adoption determinants, and impacts of micro-irrigation technologies: empirical results from India. Irrigation Science, 25(3), 283-297
O'Brien, D. M., Rogers, D. H., Lamm, F. R., and Clark, G. A. (1998). An economic comparison of subsurface drip and center pivot sprinkler irrigation systems. Applied Engineering in Agriculture, 14(4), 391-398.
Rao, A.S. (Ed.), 1994. Drip irrigation in India. Indian National Committee on Irrigation and Drainage. Ministry of Water Resources, Government of India, New Delhi, India, p. 176.
Rhoads, F. M. and Stanley, R. L. (1973). Response of three corn hybrids to low levels of soil moisture tension in the plow layer. Agronomy Journal, 65(2), 315-318.
Rivera-Hernández, B., Carrillo-Ávila, E., Obrador-Olán, J. J., Juárez-López, J. F., and Aceves-Navarro, L. A. (2010). Morphological quality of sweet corn (Zea mays L.) ears as response to soil moisture tension and phosphate fertilization in Campeche, Mexico. *Agricultural water management*, 97(9), 1365-1374.
Rosegrant, M. W., Cai, X., and Cline, S. A. (2002). World water and food to 2025: dealing with scarcity. Intl Food Policy Res Inst.
Sharma A. (2016). Climate Smart Agriculture Practices (CSA) and ICT Based Agro-Advisory Service in Nepal. Paper presented at Climate Services User Forum for Agriculture (CSUF-Ag2) Thursday, 29 September 2016 Nyi Pyi Taw, Myanmar.
Simsek, M., Can, A., Denek, N., and Tonkaz, T. (2013). The effects of different irrigation regimes on yield and silage quality of corn under semi-arid conditions. *African Journal of Biotechnology*, 10(31), 5869-5877

Srivastava, S. K., Rai, B., and Kumar, S. (2012). Role of micro irrigation in improving food productivity. India water week: water, energy, and food security.

Worlf, P. (1995). “The Problem of Sustainability of Irrigation System.” *Applied Geography* 45(46):55-62.

Xie H., You L., and Takeshima H. (2017) Invest in small-scale irrigated agriculture: A national assessment on potential to expand small-scale irrigation in Nigeria. Agricultural Water Management 193 (2017) 251–264.

4 PROFITABILITY ANALYSIS OF POULTRY EGG PRODUCTION IN IBADAN METROPOLIS, OYO STATE NIGERIA

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ABSTRACT
This study was executed to estimate the profitability of poultry egg production in Ibadan, Oyo State, Nigeria. A structured questionnaire was used to collect primary data from a cross-section survey of 120 poultry farmers gathered using a two-stage sampling technique. The data obtained was analyzed using descriptive statistics and cost and returns analysis. Results revealed that the majority (75%) were male, with an average age of 41 years. Many (64.2%) of the poultry farmers had secondary education and 25.8% had farming experience of 1-4 years. Majority (88.3%) were members of cooperative society and 87.5% operated battery cage system of poultry management. The cost and returns result showed that poultry egg production is a profitable venture in the study area given that ₦1,449,494.72 was incurred as cost per annum on egg production with ₦3,272,747.33 as revenue and a net income of ₦1,823,252.61. Furthermore, an average poultry egg farmer realized 2,504.34 crates of egg per annum and this was sold at the rate of ₦1,050 per crate. The profitability ratio further showed that for every ₦1 invested in poultry egg production, the poultry farmer earns ₦0.26 as profit. Based on the findings of this research, it is recommended that policies that will assist the poultry egg farmers to attain a drastic reduction in the cost of poultry feed possibly through subsidies should be formulated by the government. In addition, use of local materials in feed formulation that will eventually increase profit level should be encouraged.
KEYWORDS: Cost and returns, Egg, Poultry, Production, Profitability ratios

INTRODUCTION

Agriculture is a prominent non-oil sector in Nigeria that contributes remarkably to the country's economic growth. In real terms, this industry produced approximately 26.2 percent of the entire Gross Domestic Product (GDP) in 2018. The livestock business is one of the agriculture's subsectors, that employs about 25 million Nigerians directly or indirectly and primarily in the poultry industry (National Bureau of Statistics, NBS, 2018). Livestock contributed between 6% and 8% of the nation's GDP (Africa Sustainable Livestock, ASL, 2018). According to Okunmadewa (1999), livestock are tools that can improve the socioeconomic conditions of rural populace, particularly in developing countries. They can be raised on a small, medium, or big level. Nigerian livestock includes poultry (chickens), cattle, pigs, sheep, and goats. According to Federal Ministry of Agriculture and Rural Development (FMARD, 2017) report, the annual output of livestock produced in Nigeria was 18.4 million cattle, 43.4 million sheep, 76 million goats, 7.5 million pigs, 180 million poultry birds and 1.4 million equids (horses, donkeys and so on). According to Central Bank of Nigeria (CBN, 2019) report, the output realized from the poultry population was 650,000 metric tonnes (MT) of eggs and 300,000MT of meat as against the demand for eggs and meat which are about 790,000MT and 1,500,000MT respectively, thus creating a huge demand gap which are often met through smuggling from Benin Republic. There are numerous lucrative prospects in the poultry industry in Nigeria, although chickens are more commonly raised than other poultry birds. For example, broiler is reared for meat production and layers for egg production either under free range, semi-intensive and intensive system of management. Poultry offers a wide range of economic opportunities, including egg and meat production, hatcheries and input suppliers which generates additional revenue for the household. Despite the obstacles, the production of poultry products in Nigeria has increased throughout the years, but the proportion of increases still falls short of demand as it only caters for the 30% of the chicken eggs and meat needs of Nigerians as per capita egg consumption is 60 eggs per annum compared to advanced countries where per capita egg consumption is 250 eggs per annum (Babban Gona, 2021). According to Alabi and Isah (2002), the main reasons for the low poultry output in Nigeria compared to what is obtainable in other African countries are inadequate capital, diseases and parasite infection, enormous feed costs and the use of poor breed of birds. The high costs of maize and soybeans have put most poultry producers out of business (Sahel, 2015). The exorbitant cost of foreign sourced feed has caused the majority of farmers to improvise and reformulate poultry feeds with sub-standard materials such as peanut cake, cotton seed and palm kernel meal and thus exacerbating the input dilemma (World Poultry, 2013). The high cost of inputs is a big problem in the poultry industry because feed purchases consume as much as 70% of the cost of production, leading to a significant reduction in the number of commercial poultry farmers, particularly small-scale ones who are unable to bear the high-cost of egg production (Adebiyi, 2000; Ashagidigbi *et al.*, 2011) and subsequent reduction in the farmer's profit level (Hamzat *et al.*, 2020). The exorbitant input cost would undoubtedly have an impact on the income level of poultry egg producers. The Nigerian government has implemented a number of programmes aimed at addressing the issue of high input costs in the poultry industry both in the past and in the present. Some of these include the Micro-Credit Scheme for Livestock Production and the Community-Based Agricultural and Rural Development Project (African Development Fund, ADF, 2003). However, some of these programmes appears to be no longer functional possibly due to lack of funding and proper monitoring that would ensure continuity. The current study aims to evaluate the profitability of poultry egg production in Ibadan metropolis, Oyo state. The study specifically calculated the costs and returns involved in poultry egg farming.

METHODOLOGY

The research was conducted in Ibadan metropolis, Oyo State Nigeria, which comprises of 11 Local Government Areas (LGAs). It lies between longitude 3°55′0″E and latitude 7°23′47″N and has an estimated population of 6,000,000 in 2021. Ibadan has a tropical wet and dry climate, with a long-wet season and relatively consistent temperatures (between 24^{o}C and 25^{o}C) all year. Because of the favourable weather, poultry farming is popular among the farmers in the study area. A well-structured questionnaire was used to elicit relevant information that supported the study objectives from the respondents. A two-stage sampling procedure was employed in selecting the respondents. The first stage involved the purposive selection of two (Lagelu and Oluyole) out of the 11 LGAs in the metropolis due to intensive poultry egg farming in the area. The Poultry Association of Nigeria, Oyo state chapter (PANOY) provided a register of all poultry egg farmers in the selected LGAs. The second stage involved a proportionate sampling to size of 120 poultry egg farmers from the list obtained from PANOY as the number of registered poultry farmers from the two local government were not the same. 50 farmers were interviewed in Lagelu while 75 farmers were interviewed in Oluyole. Data collected were analyzed using descriptive statistics (frequency counts, percentages and mean) and cost and return analysis.

Estimation of Net Income

To determine the profit to be realized by the poultry egg producers in the study area, the profitability of egg production was evaluated using the net income estimation approach. Costs incurred and returns from egg farming were estimated, including the cost of all inputs used (fixed and variable), the quantity of output (eggs) produced in crates and the price per crate. This can be specified as shown in equations 1-4.

$$NI_i = TR_i - TC_i \quad (1)$$

$$TR_i = P_i * Q_i \quad (2)$$

$$TC_i = TFC_i + TVC_i \quad (3)$$

$$\text{Therefore, } NI_i = P_i * Q_i - (TFC_i + TVC_i) \quad (4)$$

Where: NI_i = Net income realized from the sale of egg (₦);
TR_i = Total revenue realized from the sale of eggs (₦);
TVC_i = Total variable cost expended on production of eggs (₦);
Q_i = Total quantity of eggs produced by the farmer (crates);
P_i = Current price per unit of output (₦/crate);
TFC_i = Total fixed cost expended by the farmer (₦)

Profitability ratios like Net Income (NI), Returns on Investment (ROI) and Net Profit Ratio (NPR) were calculated from the cost and returns analysis.

Following Olaoye et al., (2016), poultry egg farming is profitable if $TR > TC$; $ROI > 0.00$; $NPR > 0.00$ and NI is positive.

RESULTS AND DISCUSSION

Socioeconomic characteristics of poultry egg farmers

The socioeconomic characteristics of the poultry egg farmers sampled in the study area are presented in Table 1. Majority (75%) of the poultry egg farmers are male while very few (25%) are female. An average poultry egg farmer in study area was 41 years old with a cumulative majority (80%) below 50 years of age. This implies that the farmers were still economically active and productive, thus will be able to withstand the arduous tasks involved in poultry egg production. This result is similar to the earlier findings of Adedeji *et al.,* (2017) and Johnson *et al.,* (2020) who reported an average age of 41 years for poultry egg farmers in Oyo State, Nigeria. Majority (77.5%) of the poultry farmers are married while a few (17.5%) are single. In terms of educational qualification, very few (2.5%) had only primary education, 33.3% had secondary education while more than half (64.2%) attained tertiary education level. This high literacy rate among the farmers could bring about more informed decision and possibly increase output level as reported by Adenuga *et al.,* (2013). About one-quarter (25.8%) of the poultry farmers had between 1-4 years of experience while an average poultry egg farmer in the study area had 12 years of experience. This suggests that there are relatively few new entrants in the business, but the long years of experience could improve profit level possibly due to perfection that sets in following repetition of production activities over time as documented by Adeyonu *et al.,* (2016); Oyinbo *et al.,* (2016) and Oke *et al.,* (2022). Many (59.2%) of the respondents had 5-8 persons in their households while the mean household size was 5 persons while majority (88.3%) of the poultry farmers are members of the cooperative society. In addition, (87.5%) of the poultry farms operate battery cage system of management while just (12.5%) operate a deep litter system.

Table 1: Socioeconomic Characteristics of Poultry Egg Farmers in the Study Area

Variables	Frequency	Percentage	Mean
Sex			
Male	90	75.0	
Female	30	25.0	
Age (years)			
≤30	23	19.2	
31-40	40	33.3	
41-50	33	27.5	
51-60	18	15.0	
61 and above	6	5.0	41.2
Marital status			
Single	21	17.5	
Married	93	77.5	
Widow	3	2.5	
Separated	3	2.5	
Educational qualification			
Primary	3	2.5	
Secondary	40	33.3	
Tertiary	77	64.2	
Household size (number)			
1-4	47	39.2	
5-8	71	59.2	
9 and above	2	1.6	5
Experience (years)			
1-4	31	25.8	
5-10	36	30.0	
11-15	16	13.3	
16-20	18	15.0	
20 and above	19	15.8	11.6
Membership of cooperative society			
Yes	106	88.3	
No	14	11.7	
Poultry management system			
Battery cage system	105	87.5	
Deep litter system	15	12.5	

Source: Field Survey, 2021

Cost and Returns Analysis in Poultry Egg Production

Analysis of the profitability in poultry egg production was examined using the net income estimation approach. The cost and returns to poultry egg enterprise in the study area is presented in Table 2. The depreciated cost of fixed items (TFC) incurred was ₦121,841.30 and this represented 8.4% of the total cost (TC). The mean value of the total variable cost (TVC) was

₦1,327,653.42 per annum and this value constituted about 92.0% of the total cost (TC). Break down analysis of the total variable cost (TVC) incurred in the course of production revealed that labour cost, cost of laying birds, medications and feeds accounted for 97.9% of the total cost incurred in egg production. The table further showed that the four substantial inputs in the production of poultry eggs are feeds, laying birds, labour and medications. These significant inputs took nearly all (97.9%) of the total cost involved in egg production. It was also noticed that about 60.3% of the total cost involved was expended on feeding the birds, thus making it the most expensive variable cost item in egg production. This result is also similar to earlier documentation on the subject. For instance, recent studies in Nigeria including those of Adedeji *et al.,* (2017); Johnson *et al.,* (2020) showed that cost of feeding poultry birds accounted for the largest share of the total cost of production.

The result also showed that all other variable cost items including transportation, electricity, fuel, maintenance and repairs, water and wood shavings represented 2.1% of the total cost. In terms of revenue, an average poultry egg farmer realized 2,504.34 crates of egg per annum and this was sold at the rate of ₦1,050 per crate. The mean value realized from the sales of eggs and spent layer was ₦3,272,747.33 although egg sales represented 80.3% of the total revenue while revenue from spent poultry birds accounted for about 19.7% of the total revenue. The implication of this findings is that egg is a significant revenue source in poultry egg production. The profitability result showed that poultry egg production was a profitable venture in the study area, given a net income of ₦1,823,252.61. The profitability ratios computed in this study revealed that the returns on investment (ROI) was 1.26 which implied that for every ₦1 invested in poultry egg production, a profit worth of ₦0.26 will be realized by the farmer. In the same vein, a net profit ratio value of 0.55 generated implied that ₦0.55 will be realized as gain on every ₦1 expended on poultry egg production. The profitability ratios reported in this study are relatively higher than the Bank of Agriculture (BOA) and Bank of Industry (BOI) lending interest rate of 10%. The result further supports the findings of Afolami *et al.,* (2013) that egg production is a profitable enterprise.

Table 2: Cost and Returns Outlay in Poultry Egg Production

Items	Mean value (₦/year)	Percentage (%)
Revenue		
Quantity of eggs (crates)	2,504.34	
Price per crate (₦)	1,050.00	
Revenue from poultry eggs sold	2,629,562.75	80.34
Revenue from spent layers sold	643,187.58	19.66
Total Revenue (TR)	3,272,747.33	100.00
Variable Cost Items		
Laying birds	299,415.77	22.55
Feed	800,078.92	60.26
Medication	42,700.63	3.22
Labour	157,100.00	11.83
Transportation	10,225.00	0.77
Energy (Electricity, Fuel)	9,217.20	0.69
Maintenance and Repairs	5,650.40	0.42
Others (Water, Wood shavings)	3,265.50	0.26
Total Variable Cost (TVC)	1,327,653.42	100.00
Fixed Cost Items (Depreciated)		

Farm Vehicle	34,280.25	28.14
Land and Buildings	78,675.37	64.57
Feeding and Drinking Troughs	1,980.65	1.63
Cages	5,560.81	4.56
Empty egg crates	1,083.86	0.89
Shovels, Buckets etc.	260.36	0.21
Total Fixed Cost (TFC)	121,841.30	100.00
Total Cost (TC) = TFC+TVC	1,449,494.72	
Net Income (NI) = TR – TC	1,823,252.61	
Returns on Investment (ROI) = NI/TC	1.26	
Net Profit Ratio = NI/TR	0.55	

Source: Computed from Field Survey, 2021

CONCLUSION

The study concluded poultry egg production is a profitable venture in the study area given the net income and the profitability ratio which are both positive and greater than zero respectively. However, efforts and policies that will assist the poultry egg farmers in achieving a drastic reduction in the cost of poultry feed possibly through subsidies and also the need to encourage the use of local materials in feed formulation that will eventually increase profit level is recommended.

REFERENCES

Adebiyi, M. A. (2000). Economic analysis of egg production in Ondo State, B. Tech Project, Department of Agricultural Economics and Extension, Federal University of Technology, Akure. Pp.65 Unpublished.

Adedeji, A. P., Okuneye, P. A., Akerele, D. and Isah O. (2017). "Comparative efficiency of table egg farms under two different production systems in Oyo State, Nigeria." *World Journal of Agricultural Research*, 5(3): 135-146. doi: 10.12691/wjar-5-3-3.

Adenuga, A.H., Muhammad-Lawal, A., and Rotimi, O. A. (2013). Economics and technical efficiency of dry season tomato production in selected areas in Kwara State, Nigeria. *Agris on-line Papers in Economics and Informatics*, 5 (1): 11–19.

Adeyonu, A. G., Oyawoye, E. O., Otunaiya, A. O., and Akinlade, R. J. (2016). Determinants of poultry farmers' willingness to participate in national agricultural insurance scheme in Oyo State, Nigeria. Applied Tropical Agriculture, A publication of the School of Agriculture and Agricultural Technology, The Federal University of Technology, Akure, Nigeria. 21(3): 55-62.

Afolami, C. A., Aladejebi, O. J. and Okojie, L. O. (2013). Analysis of profitability and constraints in poultry egg farming under battery cage and deep litter systems in Ogun State, Nigeria: A comparative study. *Intrenational Journal of Agriculture and Food Security*, 4 (1 and 2): 581-595.

African Development Fund, ADF. (2003). Community-based agricultural and rural development project appraisal report. Agricultural and Rural Development Department, Central and West Regions, Federal Republic of Nigeria. 1-9.

Africa Sustainable Livestock, ASL (2018). Livestock production systems spotlight Nigeria. FAO, Rome, Italy.www.fao.org/faostat/en/#data/QA

Alabi, R. A., and Isah, A. O. (2002). Poultry production constraints. The case of Esan West Local Government Area of Edo State, Nigeria: *African Journal of Livestock Extension* 1(1): 58-

61. https://www.ajol.info/index.php/ajlex/article/view/115

Ashagidigbi W. M., Sulaimon, S.A. and Adesiyan, A. (2011). Technical efficiency of egg production in Osun State. *International Journal of Agricultural Economics and Rural Development*, 6(4):124-130.

Babban Gona (2021). Five interesting facts about poultry farming in Nigeria.https://babbangona.com/5-intersting-facts-about-poultry-farming-in-nigeria/

Central Bank of Nigeria, CBN (2019). Central Bank of Nigeria: Nigeria's poultry industry now worth N1.6trn. htpps://www.thecable.ng/cbn-nigeria-poultry-industry-worth-n1-6trn

Federal Ministry of Agriculture and Rural Development, FMARD, (2017). Federal Ministry of Agriculture and Rural Development Report 2017, Intech Open, Livestock Survey, FAO. https://onehealthdev.org/livestock-production-in-nigeria-a-thriving-industry/?amp=1

Hamzat, O.A., Taiwo, O.D. and Ogunleye, B.T. (2020). Economics of egg production among poultry farmers in Oyo State, Nigeria. *Nigerian Journal of Animal science,* 22(1): 225-232.

Johnson, S.B., Mafimisebi, T.E., Oguntade, A.E. and Mafimisebi, O.E. (2020). Factors affecting the profitability of poultry egg production in Southwest Nigeria: An application of Quantile Regression. *Review of Agricultural and Applied Economics,* 23(1): 65-72.

National Bureau of Statistics, NBS (2018). National Bureau of Statistics Report 2018. Pp 266. https://nigerianstat.gov.ng

Oke, F.O., Kareem, I.A., Bamigbade- Sanni, S.A., Oose, M.O and Olayode, A.K (2022): Economic analysis and determinants of maize production in Oyo State, Nigeria. *Nigeria Agricultural Journal,* 53(1): 60-66.

Okunmadewa, F. (1999). Livestock industry as tool for poverty alleviation. *Tropical Journal of Animal Science,* 2(2): 21-30.

Olaoye, O.J., Ojebiyi, W.G., Opele, A.I., Baiyewu, A.K. (2016). Socioeconomic analysis of small-scale fish farmers in Ilaro agricultural extension zone of Ogun State, Nigeria. *Journal of Agriulture, Forestry and Fisheries* 15(2): 64–74.

Oyinbo, O., Mohammed, O.M., Falola, A., Saleh, M.K. (2016). Technical efficiency of catfish farming in Alimosho Local Government Area of Lagos State, Nigeria: A Gender Perspective. *Agricultura Tropica et Subtropica,* 49: 45–49.

Sahel Capital (Mauritius) Limited, SAHEL (2015). An assessment of the Nigerian poultry sector. Vol. 11, Pp. 1- 3. http://sahelcp.com/wp-content/uploads/2016/12/SahelNewsletter-Volume-11.pdf

World Poultry (2013). Feed prices stunt poultry industry in Nigeria. Poultry World, Mar 5, 2013.

5 ADOPTION OF MODERN BEEKEEPING TECHOLOGIES IN SELECTED LOCAL GOVERNMENT AREAS OF BENUE STATE NIGERIA

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Abstract

This study was carried out to examine adoption of improved beekeeping technologies in selected Local Government Areas of Benue State. Three-stage sampling procedure was used to select 212 beekeepers; primary data were elicited from the respondents with the aid of a semi-structured questionnaire complemented with an interview schedule. Data were analyzed using descriptive statistics and survival Model analysis model. The findings indicated that bee suit, baiting and Kenya top bars have the highest adoption rate with beekeepers making these decisions within the first three years of their beekeeping practices. Also, water provision, hives inspection, swarm and queen catcher had moderate adoption rate. In addition, honey is the most utilized bee product; wax was occasionally utilized while propolis, bee venom, bee pollen and royal jelly were never utilized in the study area. Youth restiveness stemming from higher rate of unemployment has wreaked havoc on the study area; therefore, the study recommended that policymakers and other relevant stakeholders should promote beekeeping among youth as their level of participation is low in the study area.

Key words: Propolis, Adoption, Wax, Baiting, and Bee suit

Introduction

Agriculture is the mainstay of the Nigerian economy with regards to employment and is linked with other sectors of the economy. It contributed 23.78% to the Gross Domestic Product (GDP) in the second quarter of 2021 (Nigeria Bureau of Statistic (NBS), 2021). It is one of the most important index for measuring and comparing the economic progress of a nation. Approximately about 70% of Nigeria's active population engaged in agricultural production at a subsistence level, (Eboh, 2008). Despite the large involvement of Nigerians in agriculture, Nigerian agriculture was unable to produce enough food to meet the needs of its burgeoning population, which is expected to grow at a 2.54% annual rate (NBS, 2021). To reduce poverty and enhance livelihood in rural areas, it is essential to focus on high potential areas of agricultural sector that could be more productive as well as diversifying the source of income. Beekeeping is one of the agricultural sub-sectors where such potential exists. Beekeeping in Nigeria is a seasonal activity that predominantly remains rudimentary and unexploited but has the potential of increasing Nigeria export base (Ajao and Oladimeji, 2013). Honey and other bee by-products offer great potential for income generation, poverty alleviation and sustainable use of forest resources. Apart from honey and other by-products such as bee wax, propolis, bee venom, bee pollen and royal jelly which are highly priced globally most especially in non-producer countries, it was suggested that 35 - 73 percent of the world's cultivated crops are been pollinated by different breeds of bees indicating that most of the plant species rely on bee insects for pollination (Harshwardhan *et al.*, 2012). When compared with other agricultural sectors such as arable and cash crops, poultry, fisheries and livestock rearing, beekeeping is a comparatively low investment venture that can be undertaken by most people (men, youth, disabled, women and the elderly).

Previous studies (Bunde and Kibet 2013; Adgaba *et al.*, 2014; Gebiso, 2015; Asmiro *et al*, 2017; Jebesa, 2017) on beekeeping adoption have focused on the level of adoption and the categories of adopters. The adoption of a survival model for this study will help to clarify the time variation in the adoption of various bee technologies. Furthermore, past study has primarily focused on the economic and nutritional benefits of bee products (wax, propolis, bee venom, bee pollen, and royal jelly), with little documented evidence of beekeepers' utilization of these products. The identified gaps in the literatures necessitate the conduct of this research. Therefore, the study seeks to assess adoption of modern beekeeping technologies among rural households in selected LGAs Benue State, Nigeria and specifically; the study aimed to: describe the socio-economic characteristics of bee farmers; determine the rate of adoption of modern beekeeping technology in the study area and assess the rate of utilization of bee products in the study areas.

METHOLOGY

The study was carried out in Benue State. The state is one of the six states constituting the North Central region of Nigeria with its headquarters in Makurdi. Benue State is located between Latitude $6^0$30'N and $8^0$10'N and Longitude $6^0$33'E and 10^0E. The State covers a total land area of 33,955 square km. The human population of the State is 3,950,249 people as at 2006 Census (National Population Commission (NPC), 2006). With the state population growth rate of 3.04%, the projected population of the state is 6,474,050 people in 2020.

Three-stage sampling techniques was employed to select 212 bee farmers in the study areas derived using the Taro Yammane model as used by Sunday *et al.* (2015). Primary data were elicited from the respondents with the aid of semi-structured questionnaire complemented with interview schedule. Data were analyzed using descriptive and survival analysis

Results and Discussion

Socio-economic characteristics of beekeepers

The results in Table 1 depict that the majority (76.0%) of the beekeepers were between the age of 41–60 years, with a mean age of 50 years. This means that in the study areas, beekeeping was dominated by men who were at the margin of their active and productive age. This implies a low level of youth interest in beekeeping, which could lead to a decrease in the rate of adoption of improved beekeeping technologies. About (79.2%) had post secondary education, 19.3% had secondary education, and only (1.4%) had no formal education. This implies that beekeeping in the study areas was dominated by farmers who had the ability to read and write, which is expected to enhance the adoption of beekeeping technologies in the study areas. In addition, most (50.5%) had 6–15 years of experience, with an average of 10 years. This implies that experienced beekeepers dominate beekeeping in the studied areas, which could improve their adoption decision-making processes. Finally, most (43.9%) of beekeepers were civil servant, 38.7% were arable farmers while only 12.7% were beekeepers. This is due to their higher level of post-secondary education, which allows them to choose from a variety of paid jobs.

Table 1 Distribution of beekeepers according to socio-economic characteristics

Variables	Frequency	Percentage	Average
Age			
30 and below	1	0.5	
31 – 40	24	11.3	
41 – 50	103	48.6	
51 – 60	58	27.4	50
61 and above	26	12.2	
Level of education			
Secondary	41	19.3	
Tertiary	168	79.3	
Non-formal	3	1.4	
Beekeeping Experience			
1 – 5	63	29.7	
6 - 10	58	27.4	10
11 – 15	49	23.1	
16 – 20	42	19.8	
Primary occupation			
Farming	82	38.7	
Gathering	3	1.4	
Civil servant	93	43.9	
Artisan	3	1.4	
Beekeeping	27	12.7	
Agro-processing	3	1.4	
Student	1	0.5	

Source: Field survey, 2022

Rate of adoption of modern beekeeping technologies

The result of survival analysis presented in Table 2 revealed that bee suits, baiting, Kenya top bars had 99%, 98% and 94%adoption rate respectively.

Table 2: Survival function of adoption rate of beekeeping technologies

Bee suit					Baiting				Kenya Top Bars				Water provision				Hives inspection				swarm and queen catcher			
T	B T	F	N L	SF	B T	F	N L	SF	B T	F	N L	SF	B T	F	N L	SF	B T	F	N L	SF	B T	F	N L	SF
1	209	111	0	0.47	208	94	0	0.54	199	28	0	0.86	189	16	0	0.92	169	8	0	0.95	155	1	0	0.99
2	98	33	0	0.31	114	16	0	0.47	171	40	0	0.66	173	14	0	0.84	161	6	0	0.92	154	2	0	0.98
3	65	38	0	0.13	98	28	0	0.34	131	25	0	0.53	159	18	0	0.75	155	18	0	0.81	152	2	0	0.97
4	27	9	0	0.09	70	16	0	0.26	106	6	0	0.50	141	30	0	0.58	137	27	0	0.65	150	19	0	0.85
5	18	3	0	0.07	54	12	0	0.20	100	25	0	0.38	111	15	0	0.50	110	30	0	0.47	131	5	0	0.81
6	15	3	0	0.06	42	8	0	0.16	75	14	0	0.31	96	21	0	0.40	80	27	0	0.31	126	7	1	0.77
7	-	-	-	-	34	10	0	0.12	61	22	0	0.20	75	28	0	0.25	53	22	0	0.18	118	20	0	0.64
8	13	7	0	0.02	24	6	0	0.08	39	11	0	0.14	47	12	0	0.19	31	12	0	0.11	98	29	5	0.45
9	5	5	0	0.00	18	14	0	0.02	28	13	0	0.08	35	5	0	0.15	19	1	0	0.05	64	28	1	0.25
10	-	-	-	-	4	1	0	0.01	15	9	0	0.03	30	11	0	0.10	10	2	0	0.05	35	15	0	0.14
11	-	-	-	-	-	-	-	-	6	2	0	0.02	19	6	0	0.07	9	2	0	0.04	20	8	0	0.09
12	-	-	-	-	-	-	-	-	4	1	0	0.01	13	5	0	0.04	-	-	-	-	12	4	0	0.06
13	-	-	-	-	3	3	0	0.00	-	-	-	-	8	1	0	0.03	-	-	-	-	8	3	0	0.04
14	-	-	-	-	-	-	-	-	-	-	-	-	7	1	0	0.03	7	2	0	0.03	5	3	0	0.01
15	-	-	-	-	-	-	-	-	3	3	0	0.00	6	3	0	0.01	5	2	0	0.01	2	2	0	0.00
16	-	-	-	-	-	-	-	-	-	-	-	-	3	2	0	0.01	3	2	0	0.01	-	-	-	-
17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18	-	-	-	-	-	-	-	-	-	-	-	-	1	1	0	0.00	1	1	0	0.00	-	-	-	-

Source: Field survey, 2022. Note: T=Time; BT= Beginning Time, F=Fail, NL= Net Lost, SF=Survival Function

While water provision, hives inspection and swarm and queen catcher had 89%, 80% and 73% adoption rate respectively. Although, supplementary feeding (30%), apiary cleaning (29%), queen breading (0%), pollen collection (0%), record keeping (22%), bee pollination service (0%), honey extractor (28%), thermometer (0%), hives shading (0%), pest and disease control (1%) had low adoption rate.

The Table revealed that bee suit had 111 failures (adoption) at time "1," with a survival rate of 47%, this implies that 53% of beekeepers adopt the technology (bee suit) within the first year of their beekeeping practice. Baiting had 94 failures (adoption) at time "1," with a survival rate of 54%. This implies that 46% of beekeepers adopt the technology (baiting) within the first year of their beekeeping practice. In time ‘2’ there were16 failures (adoption) with surviving rate of 47%. Kenya top bars had 28 failures (adoption) at time "1," with a survival rate of 86%. This shows that at time “1,” period about 24% of the observation (beekeepers) had failed (adopt) the technology. At time ‘2,’ period there were 40 failures (adoption) with surviving rate of 66%. However at time 3 and 4 periods, there were 24 and 6 failure respectively.

Water provision had 16 failures (adoption) at time "1," period with a survival rate of 92%. This implies that at time ‘1’ period 92% of the observations (beekeeper) were still thinking whether to adopt the technology or not. At time ‘2,’ period there were 14 failures (adoption) with surviving rate of 84%. However, at time ‘3’, ‘4’ and ‘5’ periods, there were 18, 30 and 15 failures (adoption) respectively. Thus, about 50% of the observation (beekeepers) had fail during the ‘5’ time period. Hives inspection had 8 failures (adoption) at time "1," period with a survival rate of 95%. This Implies that at time ‘1’ period about 95% of the observations (beekeeper) were still nurturing whether to adopt the technology or not. At time ‘2,’ period there were 6 failures (adoption) with surviving rate of 92%. However, at time ‘3’, ‘4’ and ‘5’ periods, there were 18, 27 and 30 failures (adoption) respectively. Lastly, swarm and queen catcher recorded one failure at time "1," period with a survival rate of 99%. At time ‘2,’ and ‘3’ period’s two failures were recorded each. However, at time ‘4’ and ‘5’ periods, there were 19 and 5 failures (adoption) respectively. As at time ‘8’ 50% of the observations (beekeepers) had failed. In addition, at ‘6’ time period one lost was recorded, at time ‘8’ period five net losses were recorded while one lost was recorded at time ‘9’. This implies that, seven observations (beekeepers) discontinued the use of swarm and queen catcher which they attributed to lack of technical knowhow.

Level of utilization of bee products

Findings of the level of bee products utilization is presented in Table 3. The results showed that, aside honey, there was gross deficiency in bee product utilization, though bee wax was occasionally used.

Table 3 Distribution of respondent according to level of utilization of products

Bee by-products	Weighted Sum	Weighted Mean	Remark	Rank
Bee wax	515	2.4	Occasionally	2nd
Propolis	254	1.2	Never	3rd
Bee venom	258	1.2	Never	3rd
Honey	636	3.0	Always	1st
Royal jerry	212	1.0	Never	6th
Bee pollen	212	1.0	Never	5th

Source: Field survey, 2022

Due to their diverse industrial applications, bee wax and other bee products are in high demand on the international market. If all bee products are used efficiently, it has the potential to improve beekeepers' income and livelihood status and also lowering the unemployment rate in the study areas. Beekeepers who participated in wax processing, according to their responses, were unable to process wax to international standards, which has deterred man y of them from doing so. Most of the respondents choose to sell their honey with comb or extract and trash the comb instead. Others extract honey without damaging the comb and return it to the hives, making it simpler for the bees to continue their honey making process. In respect to propolis, the study found poor method of opening of top bars either for inspection or harvesting destroys the propolis which is used by bees to seal opening within the hives. Also, the low utilization of propolis can be attributed to small hive size holding of most of the beekeepers which limit the quantity of propolis they can obtain. Bee venon, which is used to treat a wide range of ailments all over the world, necessitates a great deal of technical knowledge and medical supervision. This high technicalities and proper monitoring could be attributed to their low usage. In addition, bee pollen used by bees in producing bee bread requires a lot of technicalities for their usage too. Lastly, royal jelly as expected had low utilization rate due to lack of awareness

Conclusions and Recommendation

From the study, it can be concluded that most of beekeepers were civil servant with low involvement of youth in beekeeping in the study areas. Also, bee suit has the fastest adoption rate followed by baiting and Kenya top bars while water provision, hives inspection had moderate adoption rate. Lastly, there is gross inadequacy in the utilization of bee products. Youth restiveness stemming from higher rate of unemployment has wreaked havoc in the study areas; therefore, the study recommended that policymakers and other relevant stakeholders should promote beekeeping among youth as their level of participation in beekeeping is low in the study areas.

REFERENCES

Adgaba, N., Al-Ghamdi, A., Shenkute, A. G., Ismaiel, S., Al-Kahtani, S., Tadess, Y. &Abdulaziz, A. (2014). Socio-economic analysis of beekeeping and determinants of box hive technology adoption in the Kingdom of Saudi Arabia. *The Journal of Animal and Plant Sciences*, 24 (6), 1018–7081.

Ajao, A. M. & Oladimeji, Y. U. (2013). Assessment of contribution of apicultural practices tohousehold income and poverty alleviation in Kwara State, Nigeria. *International Journal of Science and Nature*. 4 (4), 687-698.

Asmiro, A. F., Kindye, A. T., Mulugeta, A. M. & Lijalem, A. E. (2017). Adoption and of use of modern beehives in Wag Himra and North Wollo Zones, Amhara Region, Ethiopia. *Ethiopian Journal of Economics*, 26 (2), 264-282

Bunde, A. O. & Kibet, K. (2013). Socio-economic factors influencing adoption of modern bee keeping technologies in Baringo County, Kenya. *International Journal of Science and Research*, 10, 2319-7064

Eboh, E. C. (2008). State level strategies to achieve sustainable agricultural productivity, growth and Development. *Paper presented at the international Conference on Food Security*, Pp. 7 – 8

Gebiso, T. (2015). Adoption of modern bee hive in Arsi Zone of Oromia Region: Determinants and financial benefits. *Agricultural Sciences*, 6, 382–396. Retrieved April 16th 2017 fromhttp://dx.doi.org/10.4236/as.2015.63038

Harshwardhan, B., Parul, T. & Meera, S. (2012). Hymenopteran floral visitors as recorded from an Agro- Ecosystem near Bikaner, Rajasthan. *Global Journal of Science Frontie Research Agriculture & Biology*, 12 (3), 18-34.

Jebesa, S. R. (2017). Assessment of factors affecting adoption of modern beehive in East Wolega Zone, Western Oromia. *International Journal of Engineering Research and Technology*, 6 (01), 85–91.

National Bureau of Statistic (NBS), (2021). Quarterly report. Retrieved https://www.nigerianstat.gov.ng/

National Population Commission (NPC), (2006). Population and Housing Census Enumerators Manual. Federal Republic of Nigeria. 1 – 6

Sunday, I. O., Abiodun, O. A. & Chinwe, E. (2016). Assessing the knowledge level of beekeepers on improved beekeeping management practices in Peri-Urban Areas of South-western Nigeria. *Journal of Agricultural and Food Information*, 17 (2), 162 – 17

6 ADOPTION OF RECOMMENDED COCOYAM PRODUCTION TECHNOLOGIES AMONG FARMERS IN ENUGU STATE NIGERIA

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ABSTRACT

The study assessed adoption of recommended cocoyam production technologies among farmers in Enugu State, Nigeria. Multi-stage sampling procedure was used to select 245 cocoyam farmers. Structured questionnaire was used to collect primary data which was analyzed using descriptive statistics and adoption rate model. The results obtained showed that mean age of the farmers was 56 years. More than half (55.1%) of the farmers were male, while 82.4% were married and 84.1% acquired formal education. The mean household size of the farmers was 6 persons, mean farming experience was 24 years and mean farm size was 0.82 hectare. More so, only 20.4% of the farmers had access to credit facilities, while 48.6% had contact with extension agents and 26.1% were members of cooperative societies. Majority of the farmers adopted all the recommended cocoyam technologies such as fertilizer application (NPK 15:15:15) after planting (99.6%), timely planting between May–June (99.2%), planting method through internodes at 1-2cm thickness (98.8%) and harvesting by digging around cocoyam plant at about 30cm (98.8%) among others. However, in terms of adoption level, 71.0% of the respondents indicated high level of adoption, while 29.0% of the respondents indicated partial adoption level. Most of the farmers agreed that the recommended cocoyam production technologies had relative advantages ($\bar{X}$=2.81) and compatible ($\bar{X}$=3.91) while some disagreed that it is complex to put into practice with mean score ($\bar{X}$) of 2.89. The severe constraints identified by the farmers include high cost of labour ($\bar{X}$=2.85), problem of pests and diseases ($\bar{X}$=2.84), lack of fund ($\bar{X}$=2.80) and lack of improved varieties ($\bar{X}$=2.66) ranked 1st, 2nd, 3rd and 4th, respectively. It was therefore recommended that, drastic campaign should be carried out by relevant research institutes to scale-up full adoption of cocoyam technologies in production regions and beyond.
KEYWORDS: Adoption, Recommended technologies, Cocoyam production, Farmers

INTRODUCTION

Nigeria, like any other developing country is principally an agrarian nation that still face continuous food crisis as the level of food production is yet to keep pace with population demand (Amusa*et al*., 2011). Agriculture remains substantially a family business in Nigeria with low inputs and local technologies. The non-availability or inadequate use of modern agricultural technologies followed by low resource status of the farmers has made Nigeria's agriculture to remain local (Adeniji, 2002; Ajayi*et al.*, 2017). However, the challenge of inadequate food production and shortage in the supply of raw materials has led to several innovations of improved technologies that will enhance production and living standard of farmers.

In spite of the various food crop production programmes initiated and implemented by Federal Government of Nigeria (FGN), there has been growing concern about the capability of Nigeria's agriculture to satisfy the food requirement of a fast-growing population and to provide enough raw materials for the agro-based industries (International Institute for Tropical Agriculture (IITA), 2013). Emphasis therefore, is placed on production of tuber and root crops like cocoyam which has the potentials of alleviating poverty by improving the income earning capacity and food security of farmers in Nigeria. Root and tuber crops are among the most important groups of staple foods in many tropical African countries which constitute the largest source of calories for the Nigeria population (Olaniyan*et al*., 2013).

Among the root and tuber crops, cocoyam is the next in importance after cassava, yam and as well as sweet potatoes (National Root Crops Research Institute (NRCRI), 2012). Nigeria, Ghana and Japan are the world's leading producers of cocoyam (Food and Agriculture Organization (FAO), 2014). The average production figure for Nigeria is 5.4 metric tonnes which accounts for about 37% of total world's output of cocoyam (FAO, 2014). Cocoyam is regarded as a major crop especially in female headed households and has nutritional and industrial significance in flour industries (Onwubuja and Ajani, 2012). According to Chukwu*et al*. (2012), cocoyam is nutritionally superior to yam and cassava in terms of digestibility, crude protein content and essential minerals such as Calcium, Magnesium and Phosphorus.

Meanwhile, there has been decline in the yields of cocoyam in the past few years (National Agricultural Extension and Research Liaison Services (NAERLS, 2011). This is due to the usage of low-impact technologies available to the rural farmers, insufficient improved planting materials, weeds problems and poor soil that resulted to low productivity of cocoyam (Nwakor*et al*., 2015). The National Root Crops Research Institute (NRCRI), Umudike and extension agencies responsible to provides research-based information on improved cocoyam production technologies for adoption had been extending the frontier through various extension teaching methods to educate farmers (NRCRI, 2013).

It is against the backdrop of collaborative effort to prevent production of cocoyam in Nigeria from gradually going into extinction that this study was carried out, hence the following research objectives to describe the socio-economic characteristics of the cocoyam farmers; examine the recommended cocoyam production technologies and its level of adoption; assess the attributes of the recommended cocoyam production technologies and constraints associated with cocoyam production in the study area.

METHODOLOGY

Study Area

The study was conducted in Enugu State in South-East agro-ecological zone of Nigeria. The State lies between Latitude 7º 29' and 8º 55' North of the equator and Longitude 6º 26' and 7º 28' East of the Greenwich meridian with an altitude of 192 meters above sea level. Enugu State covers an estimated land area of 7,161-kilometre square (2,765sq mi) and ranks 29th out of the 36 States of Nigeria in terms of land area (Enugu State Ministry of Information (ESMI), 2019). The population is about 3,267,837 with population density of about 460-kilometre square (National Population Commission (NPC), 2006) and projected population of 5,078,975 as at 2020 using 3.2% growth rate (World Bank, 2019). The State is located in the tropical humid rain forest zone with derived savannah and experiences bi-modal rainfall pattern. Annual rainfall ranges between 1500mm – 2100mm, with mean temperature of 30.6°C (87.2°F) (ESMI, 2019). It has a well-drained fertile soil for agricultural purposes and the major occupation of the people is farming.

Sampling Procedure and Sample Size

A multi-stage sampling technique was used to select respondents for the study. In the first stage, Enugu-North agricultural zone was purposively selected due to preponderance of cocoyam farmers in the zoneout of the three Agricultural zones namely: Enugu-North, Enugu-East and Enugu-West. The zone consists of six Local Government Areas (LGAs) and eight extension blocks. In the second stage, four LGAs were randomly selected. Third stage involved selection of one extension block from each of the LGAs selected, while the fourth stage was random selection of two extension cells from each of the extension blocks to get eight extension cells. The fifth and last stage involved proportionate selection of two hundred and forty-five (245) cocoyam farmers using Taro Yamane (1967) formula based on the list of registered cocoyam farmers obtained from Enugu State Agricultural Development Programme (ENADEP).

Method of Data Collection

Primary data used for the study were collected by the researcher through the use of structured questionnaire complemented with interview schedule to obtain information on socio-economic characteristics of the farmers, recommended cocoyam production technologies, the adoption level, its attributes and constraints associated with cocoyam production.

Method of Data Analysis

Data collected was analyzed using descriptive statistics such as mean, standard deviation, frequency distribution count, percentage and charts. However, 5-point Likert rating scale of Strongly Agreed (5), Agreed (4), Undecided (3), Disagreed (2) and Strongly Disagreed (1) was used to categorized the attributes of recommended cocoyam production technologies with mean score of 3.0 as the decision rule, while 3-point Likert type rating scale of Very Severe (3), Severe (2) and Not Severe (1) was used to categorized the severity of the constraints with mean score of 2.0 as the decision rule. Also, the adoption rate model was used to generate the adoption score which was used to categorize the respondents' level of adoption into Low adopters (less than 40%), Partial adopters (41 – 70%) and High adopters (greater than 70%).

Model Specification

The adoption rate model was used to measure the adoption score of the respondents as employed and modified from Zanu *et al.* (2012). The model is specified as:

$$AR = \frac{TAF}{MSO} x\ 100 \quad (1)$$

Where;

AR = Adoption Rate

TAF = Total adoption score obtained by an individual farmer

MSO = Maximum score available

RESULTS AND DISCUSSION

Socio-economic characteristics of the respondents

As revealed in the Table 1, about half (49.8%) of the respondents were within the age bracket of 51 – 70 years with a mean age of 56 years. This implies that most of the cocoyam farmers were aged but still engaged in productive activities. This finding is in contrast with the work of

Uwandu*et al*. (2018) who reported that majority of farmers in their study area were within the youthful and middle age. More than half (55.1%) of the respondents were male, while 44.9% of them were female implying that male were more involved in cocoyam farming than female which could be due to the its tedious nature. Majority (82.4%) of the respondents were married, while 17.6% were not married (i.e. either singe, widowed or divorced). This implies that majority of the farmers were married with the main purpose for pro-creation of younger ones that could assist in farming activities. This finding agrees with Odoemekun and Anyim (2019) who reported that majority of farmers married purposely for pro-creation of young ones.

More so, more than half (56.3%) of the respondents had household size of between 5 – 10 people with a mean of 6. This implies that the farmers had relatively large household size which is an advantage in terms of farm labour supply. Majority (84.1%) acquired formal education (i.e. primary, secondary and tertiary) with a mean of 9 years of formal schooling. This implies that the farmers were literate which could help them to make better decisions as regards adoption of technologies. Educational level of an individual plays a significant role in sharpening the ability and mind of farmers for rational decision making.

Most (68.5%) of the respondents had farming experience between 11 – 40 years with a mean of 24 years of farming. This implies that the farmers had been into farming for long period of time which could enhance their favourable perception about adopting recommended cocoyam technologies. This agrees with Olaosebikan *et al*. (2019) who reported that majority of the respondents in their study area had long years of farming experience which help them to make sound decisions about their farms. Majority (88.6%) of the respondents had farm size of less than 1.1 hectares with a mean of 0.82. This implies that majority of the cocoyam farmers are operating small-scale farm holdings which could be due to competitive nature for farmland in the study area. In terms of access to credit, majority (79.6%) of the respondents had no access to credit with only 20.4% who had access. This implies that majority of the farmers had no access to credit which could negatively affect adoption of technologies. Amount of credit available to farmers enhances the adoption of modern technologies. Access to credit is a catalyst for increased agricultural production and becomes imperative for adoption. About half (48.6%) of the respondents had contact with extension agents, while 51.4% had no contact. This implies that some of the respondents had contact with extension agents is expected to influence farmers' decision to adopt recommended cocoyam technologies. Extension agents plays key role in dissemination of agricultural technologies that could improve production. More so, majority (73.9%) of the respondents were not members of cooperative societies while 26.1% of the respondents were members, implying low involvement of the farmers in cooperative societies. Membership of cooperative societies plays significant role in technology adoption behaviour of farmers.

Table 1: Distribution of the respondents based on their socio-economic characteristics (n = 245)

Variables	Frequency	Percentages	Mean
Age (years)			
< 31	9	3.7	56
31 – 50	84	34.2	
51 – 70	122	49.8	
> 70	30	12.3	
Sex			
Male	135	55.1	
Female	110	44.9	
Marital status			
Married	202	82.4	
Widowed	32	13.1	
Single	4	1.6	
Divorced	7	2.9	
Household size			
< 5	98	40.0	6
5 – 7	87	35.5	
8 – 10	51	20.8	
> 10	9	3.7	
Educational status			
Primary	102	41.6	9
Secondary	79	32.2	
Tertiary	25	10.3	
Non-formal	39	15.9	
Experience (years)			
< 11	55	22.4	24
11 – 20	66	26.9	
21 – 30	54	22.0	
31 – 40	48	19.6	
> 40	22	9.1	
Farm size (hectares)			
< 1.1	217	88.6	0.82
1.1 – 2.0	28	11.4	
Access to credit			
Yes	50	20.4	
No	195	79.6	
Extension contact			
Yes	119	48.6	
No	126	51.4	
Cooperative membership			
Yes	64	26.1	
No	181	73.9	

Source: Field Survey, 2022

Adoption of recommended cocoyam technologies by the respondents

The result in Table 2 presents the recommended cocoyam technologies adopted by the respondents. The findings revealed that majority of the farmers adopted all the recommended cocoyam technologies such as fertilizer application (NPK 15:15:15) after planting (99.6%), timely planting between May – June (99.2%), planting method through internodes at 1-2cm thickness (98.8%) and harvesting by digging around cocoyam plant at about 30cm (98.8%) among others. This implies that the farmer adopted all the recommended cocoyam technologies in the study area. This is in corroboration with the report of National Root Crops Research Institute (NRCRI) (2013) that farmers adopted recommended cocoyam technologies developed and transferred to them to boost production.

Table 2: Distribution of the respondents based on recommended cocoyam technologies adopted

Recommended cocoyam technologies	Adopted (%)	Not Adopted (%)
Timely planting between May – June	243 (99.2)	2 (0.8)
Plant spacing of 1m x 1m	204 (83.3)	41 (16.7)
Planting method using heap/ridge top	242 (98.8)	3 (1.2)
Cocoyam intercropping technique	228 (93.1)	17 (6.9)
Cocoyam mini-sets of about 25g	224 (91.4)	21 (8.6)
Fertilizer application (NPK 15:15:15) after weeding	244 (99.6)	1 (0.4)
Weed control by herbicides	240 (98.0)	5 (2.0)
Mulching using crop residues	222 (90.6)	23 (9.4)
Pest control by pesticides	240 (98.0)	5 (2.0)
Harvesting by digging around cocoyam plant at about 30cm	242 (98.8)	3 (1.2)

Source: Field Survey, 2022
*Multiple responses
Note: Numbers in parenthesis are the percentages

More so, Figure 1 shows the distribution of the respondents based on adoption level of recommended cocoyam technologies in the study area. The result revealed that in overall, majority (71.0%) of the respondents indicated high level of adoption, while 29.0% of the respondents indicated partial adoption level of recommended cocoyam technologies. The high adoption level implies that the technologies were useful and appropriate for the farmers to adopt for improved production and productivity. This finding is in agreement with Ogunwale (2012) who reported that research output do not serve any useful purpose until it is introduced to farmers, adopted by them and put into practice on their farms.

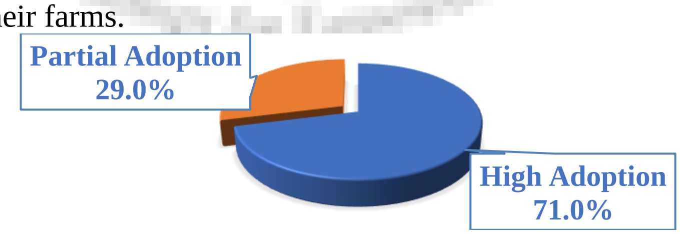
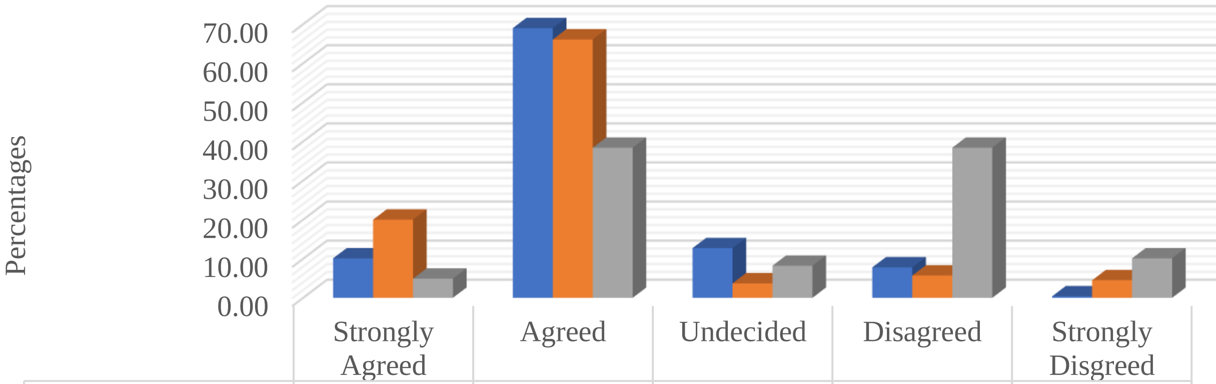


Figure 1: Level of recommended cocoyam technologies adoption by respondents

Perceived attributes of recommended cocoyam technologies by respondents
The perceived attributes of technologies considered in the study includes the relative advantage, compatibility and complexity (i.e. ease of understanding the innovation). As shown in Figure 2,

most (69.0%) and 66.1% agreed that the recommended cocoyam production technologies had relative advantages and compatible with their existing practices with mean score ($\bar{X}$) of 3.81 and 3.91, respectively. However, 38.4% of the respondents agreed and disagreed respectively that recommended cocoyam production technologies is complex to put into practise with mean score ($\bar{X}$) of 2.89. Adoption of agricultural technologies is a function of a number of attributes and factors. This is in line with the work of Ayoade*et al.* (2011) who reported that the farmers' perception on attributes of innovations are related to rates of innovations' adoption.



	Strongly Agreed	Agreed	Undecided	Disagreed	Strongly Disgreed
Relative Advantage	10.10	69.00	12.70	7.80	0.40
Compatibility	20.00	66.10	3.70	5.70	4.50
Complexity	4.90	38.40	8.20	38.40	10.10

Figure 2: Perceived attributes of the recommended cocoyam technologies by respondents

Constraints faced by the respondents in cocoyam production

Distribution of the respondents according to constraints associated with cocoyam production is presented in Table 3. Although, there was no general consensus on the constraints perceived by the farmers to hinder cocoyam production, however, the severe constraints identified by the respondents in the study area include high cost of labour ($\bar{X}$= 2.85),problem of pests and diseases ($\bar{X}$= 2.84), lack of fund ($\bar{X}$= 2.80) and inadequate improved varieties ($\bar{X}$= 2.66) ranked 1st, 2nd, 3rd and 4th, respectively. Labour as one of the important factors of production is usually in high demand especially where family labour is not available. Farmers therefore need to pay wages for hired labour at every stage of farming activities which is often on high price. Also, the role of credit to agricultural development cannot be over-emphasized as it enables farmers to advantageously utilize recommended production inputs for increased output. This finding is in agreement with that of Ogada *et al.*(2014) who reported that paucity of funds and lack of credit access constraints the adoption of improved technologies.

Other severe constraints as identified by the respondents were challenges of herdsmen ($\bar{X}$= 2.56), inadequate planting materials ($\bar{X}$= 2.40), high costs of technologies ($\bar{X}$= 2.22), poor extension services ($\bar{X}$= 2.13), complexity of cocoyam technologies ($\bar{X}$= 2.11) and inadequate farmland ($\bar{X}$= 2.66) ranked 5th, 6th, 7th, 8th, 9th and 10th, respectively. This is in line with the work of Acheampong *et al.* (2015) who reported that challenges to optimal production of cocoyam include decreasing rainfall and soil condition, loss of forests, weak technical and institutional support as well as high cost of inputs.

Table 3: Distribution of the respondents based on constraints faced in cocoyam production

Recommended cocoyam technologies	SC	LSC	NC	WS	WM	Rank	Remark
High cost of labour	209	35	1	698	2.85	1st	Severe
Problems of pests and diseases	213	24	8	695	2.84	2nd	Severe
Lack of fund	200	41	4	686	2.80	3rd	Severe
Inadequate improved varieties	162	83	0	652	2.66	4th	Severe
Challenges of herdsmen	187	9	49	628	2.56	5th	Severe
Inadequate planting material	114	115	16	588	2.40	6th	Severe
High cost of technologies	75	149	21	544	2.22	7th	Severe
Poor extension services	75	128	42	523	2.13	8th	Severe
Complexity of the cocoyam technologies	65	141	39	516	2.11	9th	Severe
Inadequate farmland	90	88	67	513	2.09	10th	Severe
Poor soil condition	47	130	68	469	1.91	11th	Not Severe
Cultural background of the people	28	78	139	379	1.55	12th	Not Severe
Lack of ready market	37	42	166	361	1.47	13th	Not Severe

Source: Field Survey, 2022

Note: SC=Severe Constraints (3), LSC=Less Severe Constraints (2), NC=Not a Constraints (1), WS=Weighted Sum, WM=Weighted Mean. Bench mean score is 2.00.

CONCLUSION AND RECOMMENDATIONS

Based on the findings of the study, it was concluded that the cocoyam farmers were aged but still engaged in cocoyam production, married and educated with at least secondary education. However, there was poor access to credit, fair contact with extension agents and poor cooperative membership. The farmers adopted all the recommended cocoyam production technologies with little variation. Thus, adoption level was high. The recommended cocoyam production technologies has relative advantages and compatible with farmers' practices but not complex. Major severe constraints are high cost of labour, problem of pests and diseases, and lack of fund. The study reported high level adoption of recommended cocoyam technologies, it was therefore recommended that more campaign should be carried out by relevant research institutes through extension agencies to ensure total adoption and scaling-up in other regions. The farmers should organize themselves into cooperative societies in order to harness benefits accrued from cooperative participation such as access to credit, extension services and training in relation to cocoyam production.

REFERENCES

Acheampong, P., Osei-adu, J., Amengo, E. & Sagoe, R. (2015). Cocoyam value chain and benchmark study in Ghana. Retrieved 12th October, 2020 from https://doi.org/10.13140/rg.2.1.4295.6326

Adeniji, O. B. (2002). Adoption of improved technologies for cotton production by farmers in Katsina State, Nigeria. Unpublished PhD Thesis submitted to Department of Agricultural Economics and Rural Sociology, Ahmadu Bello University, Zaria.

Ajayi, O. J., Muhammed, Y., Tsado, J. H., Muhammad, H. U. & Akpata, V. M. (2020). Effects of communal conflict on yam production in Agatu LGA of Benue State, Nigeria. *Journal of Agriculture and Veterinary Science*, 13 (2), 01 – 06.

Amusa, T. A., Enete, A. A. & Okon U. E. (2011). Socio-economic determinants of cocoyam production among small holder farmers in Ekiti State, Nigeria. *International Journal of*

Agricultural Economics and Rural Development.

Ayoade, A. R.;Ogunwale, A. B. &Adewale, J. G. (2011). Impact of the National Special Programme for food security on poverty alleviation among women in Oyo State, Nigeria. *African Journal of Food, Agriculture, Nutrition and Development*: 11 (4), 66 – 73.

Chukwu, G., Okoye, B. &Nwosu, K. (2012). Cocoyam Re-birth in Nigeria. Germany: Lap Lambert Academic Publishing, Pp 45.

Enugu State Ministry of Information (ESMI) (2019). Official Web Portal, Enugu State, Nigeria.

Food and Agriculture Organization (FAO) (2014). Root and Tuber Crops: Plantain and Banana in developing countries, challenges and opportunities, Serial Number 87, Pp 11 – 13.

International Institute of Tropical Agricultural (IITA)(2013).International Institute of Tropical Agriculture Annual Report 2012. Ibadan, Nigeria, Pp 15 -16

National Agricultural Extension and Research Liaison Services (NAERLS) (2011). National Report of Agricultural Performance Survey (Wet Season), December, 2010, Nigeria, Pp 175.

National Population Commission (NPC) (2006). National Population Census, Federal Republic of Nigeria Official Gazette, Lagos, Nigeria.

National Root Crop Research Institute (NRCRI) (2012). Cocoyam Programme, National Root Crops Research Institute, Umudike, National Report, Pp 322 – 323.

National Root Crops Research Institute (NRCRI) (2013). Annual Report, Umudike, Nigeria.

Nwakor, F. N., Anyaegbunam, H. N. &Olatunji, S. O. (2015). Appraisal of cocoyam technology development by NRCRI Umudike, Abia State, Nigeria. *Nigeria Journal of Agriculture, Food and Environment*, 11(1), 150 – 155.

Odoemekun, L. E.&Anyim, C. O. (2019). Determinants of Adoption of Pro-Vitamin A Cassava (ManihotesculentaCrantz.) varieties among farmers in Abia State, Nigeria. Proceedings of the 29th Annual Conference of Agricultural Extension Society of Nigeria (AESON) held at Ebonyi State on 15th – 19th, April.

Ogada, M. J., Mwabu, G. &Muchai, D. (2014). Farm technology adoption in Kenya: A simultaneous estimation of inorganic fertilizer and improved maize variety adoption decisions. *Agricultural and Food Economics,* 2: 12 – 30

Ogunwale, B. A. (2012). Socio-economic factors associated with the adoption of alley farming technology by small-scale farmers in Osun State. Unpublished PhD Thesis, University of Ife, Nigeria.

Olaosebikan, O., Abdulrazaq, B., Owoade, O., Ogunde, A., IIona, P.& Parkes, E. (2019). Gender-based constraints affecting bio-fortified cassava production, processing and marketing among men and women adopters in Oyo and Benue States, Nigeria. *Physiological and Molecular Plant Pathology*, 105, 17-27.

Olaniyan, G. O., Manyong, V. M. & Onyewole, B. (2013). The Dynamics of Root and Tuber Cropping Systems in Middle Belt of Nigeria. In: Akodora, M. O. & Ngeve, J. M. (Eds.). Proceedings of the, 7th Triennial Symposium of the International Society for Tropical Root Crops (ISTRC), Cotonou, pp 75 – 76.

Onwubuya, E. & Ajani, E. (2012). Strategies for Improving Production and Processing of Cocoyam among Women Farmers in Anambra State, Nigeria. *Journal of Agricultural Sciences*, 2 (2), 12 – 19.

Uwandu, C. N., Thomas, K. A. &Okoro, C. M. (2018). Utilization of agricultural information sources and adoption of animal and crop technologies among farming households in Imo State, Nigeria. *Journal of Agricultural Extension,* 22(1):143 – 155.

World Bank (2019). Nigeria population. Assessed on 11th November, 2020 from https://www.worldometers.info/world-population/nigeria-population.

Zanu, H. K., Antwiwaa, A. &Agyemang, C. T. (2012). Factors influencing technology adoption among pig farmers in Ashanti region of Ghana. *Journal of Agricultural Technology*, 8 (1), 81 – 92.

7 GENDER ANALYSIS OF FARMING HOUSEHOLDS' ACCESS TO LIVELIHOOD RESOURCES IN SELECTED LOCAL GOVERNMENT AREAS OF NIGER STATE, NIGERIA

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ABSTRACT

The study analyzed rural farming households' access to livelihood resources along gender lines in selected Local Government Areas of Niger State, Nigeria. The specific objectives of the study were to: describe the socio-economic characteristics of the rural farming household along gender lines; examine their access to livelihood resources; determine the factors influencing access to livelihood resources along gender lines and examine the constraints associated with accessing livelihood resources. Three-stage sampling procedure was used to select 130 rural farming household heads (67 male and 63 female). Semi-structured questionnaire complemented with an interview schedule was used to obtain primary data which was analyzed using descriptive statistics and Probit regression model. The results revealed that majority (71.7%) of the males were between 41-50 years of age with a mean of 46 years, while 47.6% of the females were in the age range of 41-50 years with a mean of 44 years. More so, 71.6% and 63.5% of the males and females farming households respectively, had household size of 1 – 5 people with mean of 6 persons. Majority (82.1%) of the males farming households had access to farmlands, while most (68.7%) of the females had no access to farmlands. In addition, more than half (56.7%) of the males had access to communication facilities, while 55.6% of the females had no access. Probit regression analysis revealed age of the males (0.0466; $P<0.05$), cooperative membership (1.6684; $P<0.01$) and annual income (-2.83e-06; $P<0.10$) to be positive and significant. In the same vein, age of the females (0.1429; $P<0.01$), cooperative membership (1.8387; $P<0.05$) and annual income (5.55e-06; $P<0.10$) were positive and significant, while marital status (-0.4836; $P<0.05$) was negative and significant. Poor credit and unfavorable government policy were the most serious constraints faced by the rural farming households along gender lines in the study area. The study recommended that government and other relevant stakeholders should provide the rural households with credit at subsidized rate to enable them enhance their livelihood. Favorable government policies should be put in place that can improve livelihood of the rural households in the study area.

Keywords: Gender, rural household, livelihood, resources, access

INTRODUCTION

Agriculture plays a pivotal role in the provision of employment opportunities and income to most rural inhabitants in developing nations, Nigeria inclusive. However, many of the rural farming communities continue to produce at subsistence level using crude implements which result in low output, thus, making farming less productive, less profitable and unattractive endeavour. This might not be unconnected to their inability to access livelihood resources. Livelihood could be described as the way people combine and use their assets, capabilities and undertake activities to secure a means of living (Micheal *et al.*, 2021). The various activities undertaken by people in order to earn income help to reduce vulnerability and increase their overall living standard within the subsisting social, economic, political and environmental influence on livelihood strategies (Eneyew and Bekele, 2012).

Nwandu *et al.* (2016) averred that the choice of livelihood activities depend largely on access to and control over five major livelihood assets/capitals which include; human, physical, social, financial and natural capitals. However, poor households face livelihood problems such as exposure to risks, malnutrition, shorter life expectancy and inadequate access to social and economic services as well as limited opportunities for income. It is a fact that, both men and women do not have the same access to livelihood resources, despite the equal roles they play in agricultural production activities. FAO (2009) posits that rural women do not have equal access and control over assets as men, particularly land and fund, reducing their socioeconomic well-being. Oyesola and Ademola (2012) stressed that rural women lack access to social assets such as networks and associations which mar their ability in political decision making. However, the female gender face inequalities in accessing education, skill development and training opportunities, particularly in the Northern part of the country attributable to religious and cultural beliefs, and this impede their capabilities. These therefore call for strategies that can help in reducing gender inequalities in accessing livelihood resources as this will not only improve nutrition, health and education outcomes, but it will help in the realization of both immediate and long-time economic and social benefits for families, communities and the nation as a whole (Aliyu *et al.*, 2021). The study was therefore conceived to extend the frontier of knowledge of farming households' access to livelihood resources along gender lines as well as factors influencing their access to such resources in the study area.

METHODOLOGY

The study was carried out in selected Local Government Areas (LGAs) of Niger State, Nigeria. Niger State lies between Latitude 8°20' and 11°30' North, and Longitude 3°30' and 7°40' East of the equator. The state covers an estimated land area of 74,244 km² with a human population of

3,954,772 people (NPC, 2006). However, the population was projected in 2021 using 3.2% growth rate of National Burenau of Statistics (NBS) to be 6,343,324 people. The state experiences two distinct seasons namely; wet and dry, with annual rainfall varying from 1100mm-1600mm. The temperature ranges from 23°C-37°C (Niger state Agricultural and Mechanization Authority (NAMDA, 2018). The major occupation of the people is farming (Crop and livestock). Four-stage sampling procedure was used to select respondents. First stage involved purposive selection of three LGAs (Bosso, Chanchaga and Wushishi) due to their predominant livelihood activities along gender lines. Second stage was random selection of two villages from each of the selected LGAs to get a total of six villages. The third stage involved stratification of the registered rural households in each of the villages selected along gender lines based on the list obtained from Niger State Agricultural Mechanization and Development Authority (NAMDA). The fourth stage involved proportionate selection of 67 males and 63 females from the stratification to get a total of 130 respondents for the study. Primary data were collected using semi-structured questionnaire complemented with an interview schedule. Data were analyzed using descriptive (frequency counts, percentage and mean) and inferential (Probit regression model) statistics.

Model Specification

Probit regression model was used to estimate the factors influencing access to livelihood resources along gender lines in the study area. The model estimates the probability of events based on dichotomous variables. A dichotomous dependent variable assumes only two values (either zero or one). Thus, the implicit form of the Probit model is specified as in equation (1):

$$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8) \quad (1)$$

The Probit regression model in its explicit form is expressed as in equation (2):

$$Y = \beta_o + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + \beta_9X_9 + \beta_{10}X_{10} + \beta_{11}X_{11} + e \quad (2)$$

Where;

Y = Access to livelihood resources by the respondents measured as 1 if access, 0 if otherwise.

X_1 = Age (years)

X_2 = Marital status (1 if married; 0 if otherwise)

X_3 = Household size (number)

X_4 = Education (years)

X_5 = Occupation (1 if employed; 0 if otherwise)

X_6 = Extension contact (1 if contact; 0 if otherwise)

X_7 = Cooperative membership (1 if member; 0 if otherwise)

X_8 = Credit (1 if access; 0 if otherwise)

X_9 = Annual income (Naira)

X_{10} = Savings (Naira)

X_{11} = Cooperative societies (number)

e = Error term

β_o = Intercept

$\beta_1 - \beta_{11}$ = Coefficients of the independent variables

$X_1 - X_{11}$ = Independent variables

RESULTS AND DISCUSSION

Socio-economic characteristics of the respondents

The socioeconomic characteristics of the rural farming household, described along gender lines are presented in Table 1. Majority (71.6%) of the male headed households were in age bracket of 41-50 years with a mean of 46 people while 47.6% were female headed who aged between 41-50 years with a mean of 44-years. This implies that most of the household heads in the study area were in their active productive age, capable of undertaking livelihood activities. This finding disagree with that of Obi-Egbodi *et al.* (2021) who in their study in Ogun State found female household heads to be above their active productive age. This may have negative implication on their access to livelihood resources. Table 1 also shows most of the household heads to be married with household size of 6 persons on the average. More so, about 35.8% of the males and 47.6% of the females had no education. Although, a greater proportion of the males possess one form of education or the other which is expected to be an advantage for the them over the females in accessing livelihood resources.

Gender Access to Livelihood Recourses

The results in Table 2 revealed that majority (82.17%) of the males had access to farmland as against 31.3% of the females who had access to farmland. This implies that greater proportion of males had access to farmland in the study area which could help them to engage more in livelihood activities like crop diversification. This finding substantiates that of Adebola *et al.* (2015) who noted that historically, in most cultures, females' access to land involved right of use, but not ownership and that when common land is converted into state ownership and then to private land, women often lose their traditional right and are not always considered when new laws are enacted. Results in Table 2 revealed that greater proportion of both males (64.2%) and females (57.1%) had no access to improved technology. This implies that rural farming households in the study area had poor access to improved technology and this could likely impact negatively on their well-being. In addition, more than half (56.7%) of the males had access to communication facilities as against 44.4% of the females rural farming households. This may be attributed to better literacy attainment by the males. Better of higher literacy level assist individual to understand how to use communication facilities and its benefits. Group membership was high for both gender, about 79.1% of the males and 88.9 % of the females were members of social group. This implies that rural greater proportion of the rural farming households in the study area were members of one group or the other. This might be attributed to their understanding of benefit derivable in group membership, as most government or international donor assistance to rural farming households are targeted at group rather than individuals.

More so, majority (62.7%) of the males were involved in decision making as against 49.2% of the females. This implies that in decision making, males have better opportunity to partake in decision making than females which could be attributed to a typical aspect of gender inequality. This finding concurs with that of Adebola *et al.* (2015) who reported the low participation in decision making by females to be a typical aspect of gender inequality. As shown in Table 2, most (61.8%) of the males and 57.1% of the females had poor access to financial resources. In terms of government support fund like grant, just a few proportion of both gender (25.4% of males and 30.2% of females) had access to such livelihood resources. This implies that majority of the rural farming households were poorly assisted which could likely impact negatively on their well-being. Furthermore, more than half (53.7%) of the males had access to quality education as against 47.6% of the females, implying that greater proportion of the males had better access to quality education. Table 2 showed that both gender (71.6% of males and 82.5% of females) had access to rural labour. This implies that the females had access rural labour which could be attributed to their ability to socialize and easily mobilize labour resources for farm operation as compared to the males. Similarly, more than half (56.7%) of the males had access to skill acquisition, while 44.4% of the

Table 1: Socio-economic characteristics of the respondents

Variables	Males (n = 67)		Females (n = 63)	
	Frequency	Percentages	Frequency	Percentages
Age (Years)				
31 – 40	10	14.9	18	28.6
41 – 50	48	71.6	30	47.6
51 – 60	4	6.0	14	22.2
Above 60	5	7.5	1	1.6
Mean	46		44	
Marital status				
Married	48	71.6	40	63.5
Divorced	6	9.0	7	11.1
Widow	9	13.4	10	15.9
Single	4	6.0	6	9.5
Household size (number)				
1 – 5	42	62.7	45	71.4
6 – 10	18	26.9	15	23.8
Above 10	7	10.4	3	4.8
Mean	6		6	
Level of education				
Non formal	24	35.8	30	47.6
Primary	20	29.9	21	33.4
Secondary	14	20.9	8	12.7
Tertiary	9	13.4	4	6.3

Source: Field Survey, 2021

Table 2: Rural households' access to various livelihood resources

Livelihood Resources	Males (n = 67)		Females (n = 63)	
	Frequency	Percentages	Frequency	Percentages
Physical resources				
Access to farmland	55	82.1	20	31.7
Access to important technology	24	35.8	27	42.9
Access to communication facilities	38	56.7	28	44.4
Group membership	53	79.1	56	88.9
Participation in decision making	42	62.7	31	49.2
Financial resources				
Access to credit facilities	26	38.8	27	42.9
Access to government support fund (grants)	17	25.4	19	30.2
Human resources				
Access to quality education	36	53.7	30	47.6
Access to good health service	56	83.6	42	66.7
Access to rural labour	48	71.6	52	82.5
Access to skills acquisition	38	56.7	28	44.4

Source: Field Survey, 2021

females had access implying that the female rarely had equal opportunities with males in participating in skill acquisition which could enhance their livelihood activities.

Factors influencing Rural Household Access to Livelihood Resources

Table 3 revealed the result of Probit model used in analyzing the factors influencing rural farming households' access to livelihood resources. Age is positive and significantly influence males access to livelihood resource ($P<0.05$), age of the females is positive (0.1453) and significant ($p<0.01$). This implies that as the respondents along gender lines in the study area advances in age they were more likely to access livelihood resources. The marital status of the females is negative (-0.4836) and significantly influenced access to livelihood ($p<0.01$), implying females that were unmarried have less chances to access livelihood resources. Cooperative membership of the males was positive (1.6684) and significantly influenced their access to livelihood resources ($p<0.001$).

Similarly, females cooperative membership had positive coefficient (1.8387) and significantly influenced their access to livelihood resources ($p<0.10$). This result revealed males that were members of cooperative societies were more likely to access livelihood resources more than the females. This might be due to disparity in recognition females always experience in the society.

The result in Table 3 further indicated that total annual income of males had positive coefficient (2.83e-06) and significantly influenced their access to livelihood resources ($P<0.10$). In the same vein, the coefficient of total annual income of the females had positive coefficient (5.55e-06) and significantly influenced their access to livelihood resources ($P<0.05$). This implies that, the more total annual income of the respondents, the more likelihood to access livelihood resources as it is believed that individuals with good socio-economic disposition were more likely to pay for whatever assistance they have received in form of loans. More so, number of cooperative membership had positive coefficient (0.5388) and significantly influenced female access to livelihood resources ($P<0.10$). This implies that the number of cooperative societies females belong, the more likely to access livelihood resources.

Constraints faced by Rural farming households in Accessing Livelihood Resources

Table 4 revealed that some constraints faced by the males considered to be very serious includes poor credit facilities ($\dot{x}=2.30$), unfavorable government policy ($\dot{x}=2.26$), lack of basic infrastructure ($\dot{x}=2.24$), poor transportation and inadequate farmland ($\dot{x}=2.22$), and high level of illiteracy. Similarly, some of the constraints considered by the females as very serious are poor credit ($\dot{x}=2.95$), unfavorable government policy ($\dot{x}=2.56$), lack of basic infrastructure ($\dot{x}=2.52$), poor transportation ($\dot{x}=2.38$) and poor storage facilities ($\dot{x}=2.22$).

CONCLUSION AND RECOMMENDATIONS

The study concluded that most of the rural farming households along the gender lines in the study area are in their middle age where they could actively engaged in productive activities. They all have access to livelihood resources with males gender have more opportunities than the females. Variables such as age, annual income and cooperative membership significantly influences male gender access to livelihood resources, while age, marital status, annual income, cooperative membership and number of cooperative societies participated in significantly influences female gender. The respondents are faced with problem of poor access to credit facilities as well as unfavorable government policies on livelihood resources. It was therefore recommended that, government and well to do individuals should assist rural farming households in the study area with subsidized credit facilities to enable them increase production. In addition, favorable government policies should be put in place that can improve livelihood of the rural households in the study area.

Table 3: Factors influencing rural household's access to livelihood resources

Variables	Males (n = 67)		Females (n = 63)	
	Coefficient	t-value	Coefficient	t-value
Age	0.0465909	1.91**	0.145299	2.45***
Marital status	0.0766397	1.29	-0.4835588	-3.14***
Household size	-0.0246522	-0.27	0.0116074	0.04
Education level	1.867527	1.56	1.096088	0.39
Occupation	-0.4770486	-1.14	0.6114843	-0.73
Extension contact	-0.4770486	-0.04	0.4257184	0.73
Cooperative membership	1.668409	3.53***	1.838672	1.66*
Access to credit	-0.6108885	-1.27	-0.3582717	-0.78
Annual income	2.83E-06	1.79*	5.55E-66	2.40**
Income savings	0.090145	0.21	0.2878936	0.65
Number of cooperatives	-0.0483143	0.54	0.538755	1.81*
Constant	-4.929692	-2.84***	-6.439628	-1.69*
Chi-Squared		24.26		32.27
Pro>chi^2		0.0143***		0.00134***
Psendo R^2		0.2612		0.3778

Source: Field Survey, 2021

Note: ***, ** and * implies significant at 1%, 5% and 10% level of probability

Table 4: Constraints faced by rural household access to livelihood resources

Constraints	VS (%)	S (%)	NS (%)	WM (ẋ)	Decision
Males (n = 67)					
Poor credit facilities	27 (40.3)	33(49.3)	7(10.4)	2.30	Serious
Unfavorable Government policy	26 (38.8)	32(47.8)	99(13.4)	2.25	Serious
Lack of infrastructure	24 (35.8)	35(52.2)	8(11.9)	2.25	Serious
Poor transportation system	29 (43.3)	32(35.8)	14(20.9)	2.22	Serious
Inadequate farmland	25 (37)	32(47.8)	10(14.9)	2.22	Serious
Community culture, value and norms	16 (23.9)	33(46.3)	18(26)	1.97	Not Serious
High level of illiteracy	22 (32.8)	31(46.3)	14(20.9)	2.12	Serious
Poor storage facilities	6 (9.0)	25(37.3)	36(53.7)	1.55	Not Serious
Females (n = 63)					
Poor credit facilities	30 (47.6)	23(36.5)	10(15.9)	2.95	Serious
Unfavorable Government policy	41 (65.1)	16(25.4)	6(9.5)	2.56	Serious
Lack of infrastructure	37 (58.7)	22(34.9)	4(6.4)	2.52	Serious
Poor transportation system	31 (49.2)	25(39.7)	7(19)	2.38	Serious
Inadequate farm land	23 (36.5)	20(31.7)	13(20.6)	2.16	Serious
Community culture, value and norms	19 (30.2)	20(31.7)	24(38.1)	1.92	Not Serious
High level of illiteracy	10 (15.9)	35(55.6)	18(28.6)	1.87	Not Serious
Poor storage facilities	21 (33.3)	35(55.6)	7(11.1)	2.22	Serious

Source: Field Survey, 2021

Note: VS = Very Serious, S = Serious, NS = Not Serious and WM = Weighted Mean

REFERENCES

Adebola, A. A., Oladimeji, I. O., Koichi, I. & Tadasu, T. (2015). Rural women farmers' access to productive resources: the moderating effect of culture among Nupe and Yoruba in Nigeria. *Journal of Agriculture and Food Security*, 4 (26), 2 – 9.

Aliyu, M. K., Ibrahim, A. L., Umar, H. S., Umar, A. M., Muhammad, K., Lawal, A., Olanipekun, O. A. & Qasim, O. H. (2021). Gender Accessibility to Agriculture Produce Resources among Rural Farmers in North-Eastern Nigeria. In: Adebayo, K. (Eds) – Redefining Agricultural Extension Practice to cope with Emergencies. Proceeding of the 26th Annual Conference of Agriculture Extension Society of Nigeria (AESON) held at Federal University of Agriculture, Abeokuta, Nigeria from 26th – 29th April, pp 108 – 119.

Eneyew, A. & Bekele, W. (2012). Department of Livelihood Strategies in Wolaita, Southern Ethiopia. *Agricultural Research and Reviews*, 1 (5), 153 – 161.

Food and Agriculture Organisation (FAO) (2009). Women and rural employment. Economic and Social Perspective Policy Brief 5, 153 – 154.

Micheal, A., Tashikalma, A. K., Kolawole, A. A. & Akintunde, A. O. (2021). Rural livelihood improvement: An assessment of household strategies and activities in Adamawa State, Nigeria. *Journal of Rural and Community Development*, 16 (1), 1 – 22.

Nwandu, P. I., Ojogbane, J. A. & Okechukwu, F. (2016). Poultry production business: A means of alternative poverty among farmer. *International Journal of Innovative Agriculture and Biology Research*, 4 (2), 21 – 30.

Nation population commission (NPC) (2006). National population census, Federal Republic of Nigeria Official gazelle, Lagos, Nigeria.

Niger state Agricultural and Mechanization Development Authority (NAMDA) (2018). Prospect of Niger State Agricultural and Mechanization Development Authority (NAMDA), Minna, Niger State, pp 18 – 20.

Obi-Egbedi, O., Omotoso, O. S. & Ajayi, O. I. (2021). Livelihood diversification gender and poverty among rural household in Osun State, Nigeria. *Journal of Rural Economic and Development*, 23 (1), 34 – 41.

Oyesola, O. & Ademola, A. O. (2012). Gender analysis of Livelihood Status among dwellers of Ileogbo Community in Aiyechie Local Government Area of Osun State, Nigeria. *American Journal of Human Ecology*, 1 (1), 23 – 27.

8 INNOVATIVE APPLICATION IN MANAGEMENT OF PROBLEMATIC SOIL (ACIDIC SOIL) UNDER MAIZE PRODUCTION IN NIGER STATE, NIGERIA

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ABSTRACT

The study examined effects of innovation application on management of problematic soil (acidic soil) in selected Local Government Area of Niger State. Multi-stage sampling techniques were used to select 180 project farmers on which primary data were elicited from the respondent with the aid of a semi-structured questionnaire complemented with interview schedule. Data were analyzed using descriptive statistics (such as frequency, percentage and mean) and OLS regression. The results obtained showed that majority (60.0%) of the project farmers in the study areas source their information on innovative means of managing problematic soil from radio, 64.8% from friends and family, and 48.0% from extension agent. Meanwhile, Agric. lime 3WBP ($\bar{X}$=4.0), Agric. lime +FYM+ NPK ($\bar{X}$=3.9), Agric lime + NPK ($\bar{X}$=3.8), Agric. Lime ($\bar{X}$=3.8) and FYM+NPK ($\bar{X}$=3.8) were the prevalent innovation application adopted by project farmers for maize production in the stud areas. The OLS regression result showed that farming experience (89.2786), relative advantage (46.0641), compatibility (1110.225) and seed rate (91.9084) had direct relation with maize output while complexibility (-353.614) and cost (-337.2121) had inverse relation with maize output. The study recommended that OCP Africa should be encouraged by the project coordinators to establish their "One Stop Shop" in the study area to enhance utilization of the technology (package).

Key words: Innovation, adoption, lime, problematic soil, management

Introduction

Land is an asset of enormous importance to billions of rural dwellers in the developing world. Right from creation, man depends on land for his basic needs of life. Martin (2010) describes land as a gift of nature to man which remains the most important factor of production. The rural dwellers depend on the environment, especially natural resources such as land, for the satisfaction of their basic needs. Land is essential natural resources, particularly land for agriculture (Umukoro, 2014). The economic development of most developing countries, including Nigeria, however, revolves, largely around the exploitation and use of land resources especially in the primary industry such as, agriculture (Titilola and Jeje, 2008). Nigeria is blessed with arable land and fresh water resources when viewed as a whole, with approximately 61 million hectares of land cultivable, while the total renewable water resource is estimated at about 280 km^3 per year (Victor, 2018). Soil conditions and water availability, if effectively managed, will help boost food production and address the food crisis in the nation. Despite the vast arable land in Nigeria, food security is still a major challenge in the country. This is majorly due to socio-institutional constraints, types of farming systems and the nature of soil. Soil acidity, which is the major problematic soil particularly in the study area, poses serious land degradation thereby reducing yield of crops especially maize (*Zea mays*). The acidification of soil may be a natural occurrence or aggravated by farmers' activities. Soil acidity is usually referred to because of its impact on crop yields as it make soil nutrients out of reach of the plant, leading to stunting of the root system. As a result, the plant also becomes less tolerant to drought (Jérôme *et al.*, 2019). As land deteriorates in quality, the poor become poorer due to low output. Therefore, proper management of the valuable resource is vital to sustain long-term agricultural productivity. Thus, the study evaluates the effects of innovation application on the management of problematic soil (acidic soil). Specifically, the study aimed to identify the sources of innovation of project farmers, determine level of innovation application by the project farmers, and examine the effects of innovation application on problematic soil by project farmers output

METHOLOGY

The study was carried out in Niger State which is located within the Latitude 10°00′N and Longitude 6°00′E with annual rainfall varying from 1300mm in the North to 1600mm in the south. The State covers a total land area of 76,363 square km with a population of 3,950,249 according to 2006 Population Census.

Multi-stage sampling techniques were employed to select 180 respondents based on National Institute of Soil Scientist (NISS) descriptive. Primary data were elicited from the respondent with the aid of a semi-structured questionnaire complemented with interview schedule. Data collected were analyzed using descriptive statistics (such as mean, frequency distribution count and percentages) and inferential statistics (such as OLS regression). The algebraic specification of the model is given as:

$Y= (\beta_1 X_1) + e,$ (1)

Where; Y = Maize output of the project beneficiaries measured in kilogram (ha); β_1 = Vector of the parameter estimated hypothesized to influence the depending variables; X_1= The victor of explanatory variables.

The model in its implicit form is specified as: Y= *f* (FM, LU, AC, SE, FE, AG, ED, FM, IF,EC, RA, CX, OB, TR, CP, AL, NPK, SR, S, FM, SSP, UR and CT)

(2)

The explicit functional forms of the multiple regression model were expressed as:

$Y = \beta_o + \beta_1 FM + \beta_2 LU + \beta_3 AC + \beta_4 SE + \beta_5 FE + \beta_6 AG + \beta_7 ED + \beta_8 FM + \beta_9 MC + \beta_{10} AC + \beta_{12} IF + \beta_{12} IN + \beta_{13} EC + U_i$

(3)

Where; Y = Maize output (Kg); FM= Farm size (hectare); LU= Labour usage (mandays); AC= Agro-chemicals (Liters) ; SE= Seeds (kg); AG= Age (years); ED= Education (years); FM= Farming experience (years); EC = Extension contact (Numbers of contact); SR = Seed rate (kg); S = Spacing (cm); RA = Relative advantage(Dummy 1 if yes and 0 if otherwise); CX = Complexity (Dummy 1 if yes and 0 if otherwise); OB = Observability (Dummy 1 if yes and 0 if otherwise); TR = Triability (Dummy 1 if yes and 0 if otherwise); CP = Compatibility (Dummy 1 if yes and 0 if otherwise); CT = Cost ₦; β_o = constant; $\beta_1 ... \beta_{16}$ = coefficients of the independent variables; U_i = Error term

ln = Natural log

Results and Discussion

Sources of Information by the Project Farmers

The results presented in Table 2 revealed that radio (60.3%), friends and family (64.4%) and extension (48.0%) were the major sources of information to project farmer on improved problematic soil management in the study area. The low utilization of Television as a source of information in the study area could be attributed to epileptic power supply by Power Holding Company of Nigeria (PHCN). It could be attributed to the high cost of TV set.

Table 1: Distribution of respondent according to sources of innovation

	Pool		Bosso		Lapai		Mokwa	
Sources	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Radio								
Yes	108	60.3	32	53.3	43	71.7	37	62.7
Television								
Yes	9	5.0	2	3.3	4	6.7	3	5.0
Friends and family								
Yes	116	64.8	38	63.3	39	65.0	39	64.1
Extension agent								
Yes	93	48.0	30	50	30	50.0	33	55.9

Source: Field Survey, 2021

Level of innovation application by the project farmers

From the result in Table 2 revealed that Agric. lime 3WBP ($\bar{X}$=4.0), Agric. Lime +FYM+ NPK ($\bar{X}$=3.9), Agric lime + NPK ($\bar{X}$=3.8), Agric. Lime ($\bar{X}$=3.8) and FYM+NPK ($\bar{X}$=3.8) were the prevalent innovation adopted by project farmers for maize production. The use of agricultural lime was generally adopted across the study areas to reduce the acidity of the soil. Majority of farmer's cultural practices including bush burning, method of fertilizer application, clean clearing and crop removal among others leads to acidification of soil. Also, natural occurrences like leaching may also cause acidification of soil. Thus the agricultural liming introduced by the project met the felt needs of project beneficiaries which accounted for it general acceptance and adoption across the study areas. Agric lime + NPK was the second mostly adopted innovative practice across the study areas for maize production. Generally maize is a cereal crop which requires high Nitrogen for it growth and development. Thus proper combination of lime and nitrogen as exemplified by the project leads to their higher adoption across the study areas. NPK (Special blend (OCP) were also highly adopted across the study areas. The reason for this result could be attributed to the fact that NPK special blended OCP were specially formulated to enhance the productivity of nitrogen demanding crops. The result demonstration as shown by the project might likely be the reason for it adoption. Spacing 25 by 75cm was highly adopted across the study areas. Proper spacing help to reduce the competition for soil nutrient, enhance proper growth and facilitate weed control. It was gathered that across the study areas farmers planted randomly using legs this tends to reduce the planting density and invariably reduce the yield and productivity of farmers. This may likely be the reason for the adoption of proper spacing across the study areas.

Table 2: Distribution of respondent according to Innovation application

	Bosso							Lapai							Mokwa							Pooled						
Variable	A	I	E	T	A	WS	WM	A	I	E	T	A	WS	WM	A	I	E	T	A	WS	WM	A	I	E	T	A	WS	WM
Agric. Lime	8	1	14	7	30	230	3.8*	9	0	18	4	29	224	3.7*	7	0	18	9	25	222	3.8*	24	1	50	20	84	676	3.8*
Agric. lime 3WBP	5	0	14	10	31	242	4.0*	6	0	20	8	26	228	3.8*	4	0	21	7	27	230	3.9*	15	0	55	25	84	700	3.9*
NPK(Spec. blend (OCP)	23	6	14	12	5	150	2.5	27	8	12	7	6	137	2.3	31	5	13	6	4	124	2.1	84	16	39	25	84	753	3.0*
Urea 46% N	4	4	23	16	13	210	3.5*	5	6	26	8	15	202	3.4*	3	7	30	4	15	198	3.4*	12	17	79	28	43	610	3.4*
farmyard manure	4	6	24	12	14	206	3.4*	8	4	24	7	17	201	3.4*	7	5	23	4	20	202	3.4*	19	15	71	23	51	609	3.4*
Farmer practice (NPK only)	5	6	24	11	14	203	3.4*	5	3	20	11	21	220	3.7*	4	2	26	7	20	214	3.6*	14	11	70	29	55	637	3.6*
Agric lime + NPK	4	4	14	16	22	228	3.8*	4	2	11	12	31	244	4.1*	3	2	11	12	31	243	4.1*	11	8	36	40	84	715	4.0*
Agric. Lime +FYM+ NPK	5	2	15	10	28	234	3.9*	4	1	15	11	29	240	4.0*	3	5	16	11	24	225	3.8*	12	8	46	32	81	699	3.9*
FYM+NPK	3	2	22	13	20	225	3.8*	9	0	18	4	29	224	3.7*	7	6	22	8	16	197	3.3*	18	9	66	33	53	631	3.5*
Seed rate 290kg per ha	9	4	13	15	19	211	3.5*	6	6	10	19	19	219	3.7*	5	8	11	17	18	212	3.6*	20	18	34	51	56	642	3.6*
Spacing 25by 75cm	7	5	11	13	24	222	3.7*	5	5	13	14	23	225	3.8*	4	4	13	16	22	225	3.8*	16	14	37	43	69	672	3.8*

Source: Field survey, 2021 Note: A= Awareness, I= Interest, E=Evaluation, T=Trial, A=Adoption and *= significant.

Effects of innovation application on problematic soil by project farmers output

The OLS regression estimate result presented in Table 3 revealed coefficient of determination (R^2) value of 0.8750. This implies that approximately about 88% variation in maize output of project farmers were explained by the independent variables included in the model, while the remaining 12% unaccounted variation could be due to error or other variables not captured in the model. The F – ratio is statistically significant at 1% probability level implying the perfect fit of the model and good at predicting the observed data.

The coefficient of farming experience (89.2786) was positive and significant at 5% probability level. This implies that a unit increase in farming experience may leads to 89.28 increases in the maize output of project farmers. The coefficient of relative advantage (46.0641) was positive and significant at 1% probability level. This implies that a unit increase in relative advantage may leads to 46.06 increases in the maize output of project farmers. The coefficient of compatibility (1110.225) was positive and significant at 5% probability level. This implies that a unit increase in compatibility may leads to 1110 increases in the maize output of project farmers. The coefficient of seed rate (91.9084) was positive and significant at 1% probability level. This implies that a unit increase in seed rate may leads to 91.9 increases in the maize output of project farmers. The coefficient of complexity (-353.614) and cost (-337.2121) were negative and significant at 5% and 10% probability levels, respectively. This implies that a unit increase in complexity and cost of innovation may leads to353 and 337 decreases in the maize output of project farmers.

Table 3: Regression estimate on effects of innovation application on problematic soil by project farmers

Variables	Coefficient	t-value
Farm size	-606.5399	-1.47
Labour usage	282.8499	0.96
Agro-chemicals	4.1506	0.35
Seeds	3.5124	0.17
Age	79.8519	0.71
Education	-4.9218	-0.44
Farming experience	89.2786**	2.36
Extension contact	-21.4512	-0.11
Relative advantage	46.0641***	3.94
Complexity	-353.614***	-2.50
Observability	123.9014	0.58
Triability	437.5892	0.44
Compatibility	1110.225**	2.15
Cost	-337.2121*	-1.93
Seed rate	91.9084***	4.03
Spacing	.3240	0.06
Constant	-1254.841	-1.15
R-squared	0.8750	
Adjusted R-squared	0.8301	
F-ratio	0.0000	

Source: Field Survey, (2021) *Note figures in parenthesis are the T-values *** significant 1% probability level, ** significant 5% probability level and * significant 10% probability level

REFERENCES

Jérôme B., Jordan C. & James, W. (2019). Experts are developing data and dashboards to advise policymakers about the cost and feasibility of liming to increase maize productivity. New tools guide interventions against acid soils in Africa using lime. *Journal of Soil and Water Conservation*, 45(3), 431–436.

Martin, D. (2010). Nigeria land reforms –the lingering debate an article in the daily independence http://www.independentngonline.com/ accessed on 1 Jan, 2010

Titilola S. O. & Jeje, L. K. (2008). Environmental degradation and its implications for agricultural and rural development: the issue of land erosion. *Journal of Sustainable Development in Africa*, 10(2), 116-14

Umukoro, J. O. (2014). Influence of cropping system, land type and sustainability of land degradation in South Western, Nigeria. A Ph.D. Thesis of University of Ibadan, Pp. 244

Victor, S. (2018). Adoption of improved technologies by the pig farmers of Aizawl district of Mizoram, India. *Livestock* Research for *Rural Development*, 19, 1–5.

9 EFFECTS OF RISK MANAGEMENT STRATEGIES ON POVERTY STATUS OF RICE FARMERS IN NIGER STATE, NIGERIA

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ABSTRACT

This paper examined the effects of risk management strategies on poverty status of rice farmers in Niger State. Primary data were used, collected using semi-structured questionnaire. A multistage sampling procedure was employed to select 377 respondents for this study. Data were analysed using Tobit Regression Model. The objective was to assess how farmers' risk management strategies affect their poverty status in the study area. The results revealed that contract farming improved productivity in the contracted crop resulting in additional increase in income for the farmers. The additional income from off-farm employment was found to reduce poverty levels through its positive contribution to welfare indicator. Thus, farmers that participated in this aspect of farming are better off due to the additional income from their involvement in these activities. The study also revealed that the poverty status of the farmers in the study area was significantly influenced by the risk management strategies they adopted. Thus the farmers were generally not poor as most of them engaged in production diversification which led to reduction in the risk situations they faced. Farmers are therefore encouraged to adopt more risk-management strategy especially production diversification as it would lead to reduction in the probability of the farmers becoming poor.

Keywords: Poverty, Risk, Management Strategies, Diversification, Rice Farmers.

1.0 INTRODUCTION

Poverty remains widespread within farmers in Nigeria. This is no longer a controversial issue. What is controversial is the choice of appropriate risk management strategies for poverty reduction (Nguezet, *et al.*, 2011).Despite the numerous programmes embarked upon by the Nigerian government over the years to improve the livelihood of the rice farmers; the average Nigerian rice farmer remains poor. The uncertainties inherent in weather, yields, prices, government policies, and other factors that impact on farming can cause wide swings in farm income. (USDA, 2022).

Statistics indicate that over 60 percent of the population of Niger state are farmers engaged in production of rice, yam, melon and groundnut (Niger State Agricultural and Mechanisation

Development Authority (NAMDA), 2015). These farmers operate mainly within the limits of their insufficient resources which tend to constrained their capacity to employ most recommended risk management technologies. This diminishes their ability to optimize crop production for both domestic consumption and income generation.

There have been studies on poverty and risk management strategies in Nigeria. The closest study to this present study is the work of Akosua (2012), which addressed poverty, risk and management strategies of rice farmers in selected local government areas of Plateau state. The studies however did not relate risk attitudes to rice farmer's poverty. However, this study assessed the effects of risk management strategies on poverty status of rice farmers in the study area. Niger State is one of the major food producers in Nigeria. In 2017, the state was ranked the leading rice producer in the country (National Agricultural Extension and Research Liaison Services (NAERLS), 2017). Yet, the poverty level in the state rose to 61.2% in the same year (National Bureau of Statistic (NBS, 2017).

2. Research Methodology

Primary data were used for this study. The data were collected using semi- structured questionnaire administered to rice farmers in Niger state. The state lies on latitude 3.20° East and longitude 11.30° North. The estimated land area is 76,363 square kilometres with a population of 3,950,249 people (NPC, 2006). The state consists of 25 Local Government Areas (LGAs) with three major ethnic groups (Nupe, Gbagyi and Hausa) and three Agricultural zones namely I, II and III (NAMDA, 2015). Six (6) LGAs, 2 from each agricultural zone were purposively selected due to high concentration of rice farmers in these areas. Thirty (30) villages, 5 from each LGA were randomly selected. Finally eighteen percent (18%) of the sample frame (1885) was used as the sample size. In all, 377 rice farmers were randomly selected. Tobit regression was used to determine the effect of the explanatory variables on the probability of being poor. The empirical model is specified as follows:

$$\underline{Y_i} = P_0 X_0 + P_1 X_1 + P_2 X_2 + P_3 X_3 + P_4 X_4 + P_5 X_5 + P_6 X_6 + P_7 X_7 + P_8 X_8 + P_9 X_9 + P_{10} X_{10} + P_{11} X_{11} + P_{12} X_{12}$$

$$+ P_{13} X_{13} + P_{14} X_{14} + P_{15} X_{15} + e_i \ldots\ldots\ldots\ldots\ldots\ldots 1$$

Where:

Y_i = Poverty gap

e_i = Truncated error term

P_0 = Intercept term

P_1 - P_{15} = Slope coefficients

X_1 = *Sharing in crops*

X_2 = *Contract farming*

X_3 = *Spread of sales*

X_4 = Off-farm employment income

X_5 = Risk management training

X_6 = Production diversification

X_7 = Gender of farmer

X_8 = Age of farmer in years

X_9 = Educational level in years

X_{10} = Marital status

X_{11} = Number of household size

X_{12} = Years of farming experience

X_{13} = Number of years in cooperative membership

X_{14} = Farm size in hectares

X_{15} = Number of contact with extension agent

3.0 RESULTS AND DISCUSSION

The result of the Tobit model is presented in Table 1. The result shows that 5 out of 16 variables included in the model are statistically significant with farmer's poverty status. The estimated coefficient (-0.199) of contract farming is negative and statistically significant ($p < 0.01$) in influencing farmer's poverty status. This implies that, an increase in contract farming as risk management strategy reduces the farmer's probability of being poor. Engaging in contract farming improved productivity in the contracted crop and could spill over to other crops, resulting in additional increase in income. The result corroborated with the findings of Diagne & Zeller (2001) that there is a negative relationship between contract farming and farmer's poverty in Malawi.

Similarly, the coefficient (0.391) of off-farm employment income is positive and significant at ($p < 0.05$) level. This implies that, an increase in off-farm employment as risk management strategy among rice farmers, would lead to an increase in the probability of the farmers becoming poor in the study area. Although, this finding is at variance with the *a priori* expectation where increase in off-farm activities should reduce the poverty level. This finding is at variance with the findings of Oladimeji *et al*., (2015) who asserted off – farm income as an important determinant of poverty and reported that an increase in off farm activities will lead to extra household income which could reduce the poverty level of the farmers. Furthermore, the coefficient (-0.0061) of productions diversification was found to be negative and significant at ($p< 0.10$) level. This implies that, an increase in productions diversification as risk management strategy among rice farmers will lead to reduction in the probability of the farmers becoming poor by 0.6%.

The coefficient of socioeconomic variables revealed that the level of education is significant ($p < 0.05$) and inversely related with the poverty status of the rice farmers in the study area. This implies that as the level of education of the farmers increase the poverty status of the farmers decrease. The coefficient of farming experience was also found to be negative and statistically significant ($p < 0.10$) with the poverty status of the farmers. This means that an increase in the level of education reduces the probability of the farmers becoming poor.

Table 1: Effects of risk management strategies on farmers' poverty status

Poverty status	Coef.	Std. Err.	P-Value
Sharing in crops	0.501	0.396	0.207
Contract farming	-0.199	0.378	0.598***
Spread of sales	0.113	0.412	0.007
Off farm employment income	0.391	0.526	0.133**
Risk management training	0.0075	0.0142	0.53
Production diversification	-0.0061	0.0481	0.05*
Gender	0.407	0.363	0.264
Age	0.022	0.024	0.364
Educational level	-0.055	0.039	0.163**
Marital status	-0.594	0.614	0.334
Household size	0.048	0.138	0.725
Farming experience	-0.076	0.044	0.084*
Membership	-0.052	1.461	0.972
Farm size	0.047	0.081	0.559
Access to extension	-0.123	1.361	0.928
Constant	5.233	4.646	0.261
/Sigma	2.717	0.144	
Log likelihood	-549.546		
LR chi^2 (15)	647.32		
Pseudo R^2	0.3796		
Prob > chi^2	0.0000		
Marginal effects after tobit			
y= effects (predict)	0.604		

***Significant at 1% level **Significant at 5% level *Significant at 10% level

4.0 CONCLUSION AND RECOMMENDATION

Essentially, farmers in the study area are conscious of the risk management strategies as most of them adopted one or more risk management strategies which affect their poverty status at various significant levels. Hence, production diversification, off-farm employment and contract farming have attracted attention in the study area as a potential catalyst for mitigating risk situations in farming and improving poverty status of the farmers. Therefore, to achieve high livelihood and more stable income efforts should be geared towards training the farmers on the appropriate management strategies with emphasis on in production diversification in the study area.

REFERENCES

Akosua, O.Y.(2012) Analysis of Poverty, Risk and Coping Strategies of Irish Potato Famers in Selected Local Government Areas of Plateau State, Nigeria Department of Agriculture Economics and Rural Sociology Faculty of Agriculture Ahmadu Bello University Zaria, Kaduna State, December, 2015

Diagne, A. & Zeller, M. (2001). Access to Credit and Its Impact on Welfare in Malawi, Research Report 116, Washington, DC: International Food Policy Research Institute.

Minot, N., and B. Sawyer. (2014). Contract Farming in Developing Countries: Theory and Experience. Report prepared for the Investment Climate Unit, International Finance Corporation. Washington, DC: International Food Policy Research Institute.

NAERLS (2017). The report of National Agricultural Extension and Research Liaison Services of Ahmadu Bello University, Zaria, in conjunction with Agricultural Development Projects and the Federal Department of Agricultural Extension for the year 2017

NAMDA (2015). Niger State Agricultural and Mechanisation Development Authority Annual Report for the year, 2015

National Population Census (2006). Report of head count of Nigerian citizens conducted by National Population Commission in 2006.

NBS (2017). National Bureau of Statistic annual Report for the year, 2017

Nguezet,D.P.M, Diagne, A., Okoruwa, V.O and Ojehomon, V (2011) Impact of Improved Rice Technology on Income and Poverty among Farming Households A local Average Treatment Effect (LATE) Approach. Contributed Paper Prepared for the 25th Conference of the Centre for the Studies of African Economies (CSAE). St. Cathrine College, University of Oxford, United Kingdom.

Oladimeji, Y.U.Abdulsalam, Z and Abdullahi, A.N.,(2015). Determinant of participation of rural farm households in non-farm activity in Kwara State, Nigeria; A Paradigm of Rural Poverty. *EthiopianJournal of Environmental Studies and Management* 8(6): 635 –649.

USDA (2022). United State Department of Agriculture, June 16, 2022.

10 EFFECTS OF FARMER-HERDER'S CONFLICT ON THE FARMERS PRODUCTIVITY IN ADAMAWA STATE, NIGERIA

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Abstract

The study examined the effects of farmer-herder conflict on the productivity of farmers in Adamawa State, Nigeria. Multistage sampling technique was used to select 300 food crop farmers from 180 conflict-affected areas and 120 less affected areas. Primary data were collected from the respondents using a structured questionnaire supplemented with an interview schedule. Data were analyzed using descriptive and inferential statistics. The result showed that loss of human life/properties, reduction of social activities, high cases of rape, theft and robbery, overdependence and begging, acquiring of weapons/arms and sexual harassment of women were the major effects conflicts of on socio-economic lifestyle of the farmers. Also, households size (3333), labour inputs (3.3391) and conflict (-5746) were the major factors influencing the productivity of food crop farmers in the study area. The study recommended that Federal and State government should involve conflict resolution expertise for peace building dialogue and also involve local leaders in peace building policies.

Key words: Conflict; Productivity; Herder; Farmer; Local leaders

Introduction

Agriculture is the backbone of Nigeria economy which serves as sources of livelihood and economic sustenance for the majority of Nigeria's teeming population, (Heady and Hodge, 2009). About 70% of the Nigeria's populations are farmers. Farmers and herders are the major players in agricultural activities that significantly contribute to meeting the nutritional needs of the country and thus contributing to national food security and economic development (Onuoha and Ezirim, 2015). The herdsmen and farmers represent one of the most highly populated groups in Adamawa State, (Bello, 2013). It is worthwhile to note that in the past, agricultural farmers and pastoralist groups had a cordial and stable relationship that enabled the people to work side by side for decades, though there were usually points of contention between the two groups that were normally resolved peacefully (Christopher and Ademola-Adelehin 2017). This type of relationship, which has existed for many centuries, has sadly been cut short by numerous conflicts that have broken out across the various regions and resulted in extensive violence, fatalities, and internal displacement of people. Farmers and Fulani pastoralists continue to engage in violent clashes as a result of social and economic issues, these conflicts have constituted serious threats to the means of survival and livelihoods of both the farmers and herders with what both groups are tenaciously protecting. Farmers-herders' conflicts do not only have a direct impact on the lives and livelihoods of those involved; they also disrupt and threaten the sustainability of agriculture, especially food production and security in Nigeria. It also results in hunger and a shortage of nutritious, safe food, which consequently affect the gross domestic product of the country at large. Since the incessant conflict between farmers and herders in Nigeria, few studies have been conducted to determine the effects of farmer–herder conflicts in Adamawa State. This has created a gap in knowledge that needs to be filled. This study, therefore, seeks to examine the effects of the conflicts between farmers and herders on the productivity of farmers within the affected areas of the state. Specifically, the study aimed to determine the effects of farmer-herder's conflicts on socio-economic lifestyle of the farmers in the study area; and determine the effects of farmer-herder's conflict on the productivity of food crop farmers in Adamawa State.

Methology

The study was carried out in Adamawa State. Adamawa State lies between longitudes 12°30'E of the Greenwich Meridian and latitude 9°20'N of the Equator. The state has a human population of 3,178,950 according to the 2006 population census, which was projected to be about 4,763,070 in 2020 at a 2.9% growth rate per annum (National Bureau of Statistics (NBS), 2020), and it covers an estimated land area of 39,940 square kilometers.

Sampling techniques and sample size

A multi-stage sampling technique was used to select the 180 most affected and 120 least affected farmer-herder conflict zones. A total of 300 respondents were used as the sample size for the study.

Method of data collection

Primary data were used for the study, which were obtained using a structured questionnaire and interview schedule.

Analytical techniques

Descriptive and inferential statistics were used to analyze the collected data.

Model specification

Total Factor Productivity index

The total factor productivity is expressed as follows:

Total Factor Productivity (TFP) = *VOP/VIE;* Let (TFP) index be Y; VOP= Value of Output in Naira; VIE= Value of Inputs Employed in Naira.

Multiple Regressions

The model is implicitly specified as follows;

Linear: $Y = f(\beta_0+ \beta_1X_1+\beta_2X_2+\beta_3X_3+\beta_{4,}X_4+\beta_5X_5+\beta_6X_6+B_7X_7+\beta_8X_8+\beta_9X_9+\beta_{10}X_{10}+\beta_{11}X_{11}+\beta_{12}X_{12} +\beta_{13}X_{13}+\beta_{14}X_{14})$

Double log: $\ln Y = f(\beta_0+ \beta_1\ln X_1 + \beta_2\ln X_2 + \beta_3\ln X_3+\beta_4\ln X_4+\beta_5\ln X_5+\beta_6\ln X_6+\beta_7\ln X_7+\beta_8\ln X_8+\beta_9\ln X_9+\beta_{10}\ln X_{10}+\beta_{11}\ln X_{11}+\beta_{12}\ln X_{12}+\beta_{13}\ln X_{13}+\beta_{14}X_{14}\ldots)$

Semi log: $Y = f(\beta_0+ \beta_1\ln X_1 +\beta_2\ln X_2+\beta_3\ln X_3+\beta_4\ln{,}X_4+\beta_5\ln X_5+\beta_6\ln X_6+B_7\ln X_7+\beta_8\ln X_8+\beta_9\ln X_9+\beta_{10}\ln X_{10}+\beta_{11}\ln X_{11}+\beta_{12}\ln X_{12}+\beta_{13}\ln X_{13}+\beta_{14}X_{14\ldots.})$

Exponential: $\ln Y = f(\beta_0+ \beta_1X_1 + \beta_2X_2+\beta_3X_3+\beta_{4,}X_4+\beta_5X_5+\beta_6X_6+B_7X_7+\beta_8X_8+\beta_9X_9+\beta_{10}X_{10}+\beta_{11}X_{11} +\beta_{12}X_{12}+\beta_{13}X_{13}+\beta_{14}X_{14\ldots})$

Where: Y = Total Factor productivity Index; X_1= Conflict (no of attacks); X_2 = Age of farmers (years); X_3 = Deaths Recorded by a household (no of persons killed); X_4 = Distance to the market, (kilometer); X_5 =Extension Contact (numbers of visit in a year); X_6 = Seed used (Kg); X_7 = Family size (Number of people); X_8= Level of education (Years); X_9= Farming experience (Years); X_{10}= Farm size (Ha); X_{11}= Labor input (Man-day); X_{12}= Agrochemicals (liters); X_{13}= Loan facilities received (Naira); X_{14}= Health Status of farmer as a result of injuries sustained by conflict (amount spent on drugs in Naira).

Results and Discussion

Effects of farmer-herder's conflicts on socio-economic lifestyle of the farmers

The results of likert rating scale in the Table 1 reveals that loss of human life, reduction of social activities was ranked the most important of effects of farmer-herders clash on the life style of farmers. This is similar to the study of Ofuoku and Isife (2010) who opined that loss of life, displacement of farmers and land degradation were some of the effects of farmer-herders conflict in Nigeria. The study found that a lot of killings were recorded by the herders in the host communities due to the lingering conflict between the two groups. In retaliation for the colossal damage by the herders, a reprisal killing of nomads by the host communities was recorded too. It was discovered that some of the victims were badly injured while others were maimed. The implication of this finding is that there will be a reduction in the number of able-bodied farmers to carry out agriculture. Also, some of the victims may be depressed for the rest of their lives, and farmers may face a drop in labour availability.

High cases of rape, overdependence, and begging, as well as theft and robbery, were ranked the third perceived effects of farmer-herder conflict. Most nomads are single and mostly migratory. Therefore, in a bid to satisfy their sexual desire (thirst), during conflict, they resort to raping and sexually harassing females (the underage ones, married and unmarried, as well as the widowed). This usually leaves a scar in the hearts of the victims, intensifying the hostility between farmers and herders. It was gathered that the acquisition of weapons by herders which they used on their victims had resulted in some members of host communities acquiring weapons in order to repel their attacks. This has accelerated the procurement of weapons in both the study areas and Nigeria as a whole. As a result of the high prevalence of weapon infiltration in the country, many incidents of societal vices have emerged (banditry, kidnapping, and theft). Finally, farmers were displaced as a result of house destruction, and those who remained stopped going to a distant farm for fear of being attacked. This has increased the rate of refugees in the study area. Thus, farmers have become burdens to other farmers, forcing them to rely on others for food for themselves and their families. As a result, many communities have become trapped in a cycle of poverty.

Table 1: Distribution of respondent according to effects of farmer-herder's' conflicts on socio-economic lifestyle of the farmers

S/n	Perceived effects	SD (%)	DA (%)	N (%)	A (%)	SA (%)	WS	WM	Rank
1	Sexual harassment of women	7 (2.3)	61 (20.3)	4 (1.3)	97 (32.3)	131 (43.7)	1184	3.9*	8th
2	Acquiring of weapons/arms	6 (2.0)	21 (7.0)	17 (5.7)	140 (46.7)	116 (38.6)	1234	4.1*	6th
3	Loss of human life/properties	2 (0.7)	1 (0.3)	7 (2.3)	56 (18.7)	234 (78.0)	1419	4.7*	1st
4	High cases of rape	9 (3.0)	28 (9.3)	9 (3.0)	93 (31.0)	161 (53.7)	1244	4.2*	3rd
5	Reduction of social activities	0 (0.0)	0 (0.0)	59 (19.7)	80 (26.7)	161 (53.7)	1282	4.3*	2nd
6	Theft and robbery	1 (0.3)	16 (5.3)	0 (0.0)	166 (55.3)	117 (39.0)	1262	4.2*	3rd
7	Overdependence and begging	1 (0.3)	32 (10.7)	0 (0.0)	151 (50.3)	116 (38.7)	1249	4.2*	3rd
8	Increase in refugees	3 (1.0)	22 (7.3)	57 (19.0)	102 (34.0)	116 (38.7)	1206	4.0*	7th

Source: Field survey, 2021

Note:*=Agreed, Decision rule: $\bar{X} \geq 3$=Agree and $\bar{X} < 3$ =Disagree; SD= strongly disagree, D=Disagree, N= Neutral, A=Agree and SA= Strongly Agree; WS= Weighted Sum, WM= Weighted Mean

Effects of farmer-herder's conflict on the productivity of food crop farmers in Adamawa State

From the regression analysis result presented in Table 2 the coefficient of determination (R^2) value was 0.4539 implying that about 45% variation in productivity of food crop farmers was explained by the independent variables included in the model. The coefficient for conflict (-5746) was negative and statistically significant at 0.01 probability level. This implies that a unit increase in numbers of conflict will lead to decrease in the productivity of farmers. This has the expected a *priori*, this is because increase in farmers-herders crises may likely leads to destruction of crops or displacement of farmers which will prevent them from going to maintain their farms thus their productivity is expected to reduce. The coefficient for household (3333) was positive and statistically significant at 0.01 probability level. This implies that a unit increase in household will increase the productivity of food crop farmers. The household size plays an important role in determining what occurs on the farm. It provides the human factor in farming through labour and management inputs. The household's demands may motivate the adoption of recommended practices as a means to meet the increasing family demands. Thus, the productivity of farmer is expected to improve. Although, large households size may increase the expenditure of households thereby decreasing the amount of resources available to adopt new innovation that can improve their productivity. The coefficient for Labour input (3.3391) was positive and statistically significant at 0.01 probability level. This implies that a unit increased in labour input will lead to 3.3391 increases in productivity of food crop farmers. This has the expected *a priori*, this is because increase in availability of labour for carrying out varieties of farming operation will increase the productivity of the farmer. The reason for this result could be attributed to large household availability in the study areas.

Table 2: Effects of farmer-herder's conflict on the productivity of food crop farmers in Adamawa State

Variables	Coefficient	t-value
Conflict	-5746***	-8.08
Age	3349	0.81
No of extension contact	3507	0.23
gender	1135	1.44
experience	4968	1.01
Households size	3333***	4.41
education	7960	1.23
Total farm size	1277	0.46
Total farm size	1277	0.46
Total agrochemical	1125	1.27
Labour input	3.3391***	7.40
fertilizer	22.37	0.05
Total credit	.0794	0.76
Constant	6843	3.56
R- squared	0.4539	
Adj R- squared	0.4290	
F-ratio	0.0000	

Source: Field survey, 2021 Note: *** implies statistically significant at 1%, ** implies statistically significant at 5%, * implies statistically significant at 10%.

Conclusion and recommendation

The study examined the effects of farmer-herder's conflict on the productivity of farmers in Adamawa State, Nigeria. From the study, it can be concluded that loss of human life/properties, reduction of social activities, high cases of rape, theft and robbery, overdependence and begging, acquiring of weapons/arms and sexual harassment of women were the major effects conflicts on socio-economic lifestyle of the farmers While conflict households size and labour inputs were the major factors influencing the productivity of food crop farmers in the study area.

From the study the incessant Fulani herdsmen and Farmers conflict have negative implications on productivity and food security status of farmer which results to extreme poverty, therefore it is recommended that Federal and State government should involve conflict resolution expertise for peace building dialogue and also involving local leaders in peace building policies.

References

Bello, A. S. (2013). Herdsmen and Farmers Conflicts in North-Eastern Nigeria: Causes, Repercussions and Resolutions. *Academic Journal of Interdisciplinary Studies*.2 (5), 29-139.

Christopher, M. A. K. & Ademola-Adelehin, B. I. (2017). The Implications of The Open Grazing Prohibition and Ranches Establishment Law on Farmer-Herder Relations in The Middle Belt of Nigeria," *Search for Common Ground* (2017) https://www.sfcg.org/wp-content/uploads/2018/02/Open-Grazing-Prohibition-Law-in-Benue-State-December-2017.pdf accessed on 23rd September 2019

Heady, D. D., & Hodge, A. (2009). The effect of population growth on economic growth: A meta-regression analysis of the macroeconomic literature. *Population and Development Review*, 35, 221-248.

National Bureau of Statistic (NBS), (2020). Quarterly report. Retrieved from https://www.nigerianstat.gov.ng/

Ofuoku, A. U., & Isife, B. I. (2010). Causes, Effects and Resolution of Farmers-Nomadic Cattle Herders Conflict in Delta State, Nigeria. *International Journal of Sociology and Anthropology*, 1(2), 47-54

Onuoha, F. C. & Ezirim, G. E. (2015). Climate change and national security. *Journal of Agricultural Policy and Research*, 1(55), 233-242

11 EFFECTS OF ADOPTION OF IMPROVED BEEHIVE TECHNOLOGIES ON INCOME AND WELFARE STATUS OF BEEKEEPERS IN EKITI STATE, NIGERIA

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ABSTRACT
The study was carried out to assess the effects of the adoption of improved beehive technologies on beekeeper's welfare status in Ekiti State, Nigeria. Four-stage sampling techniques were adopted to select 249 respondents for the study. Questionnaires complemented with interview schedule were used to collect primary data from respondents. Data were analyzed using descriptive (such as frequency count, percentage and mean) and inferential statistics (such as the Gini coefficient and Seemingly Unrelated Regression (SUREG)). The results revealed, the average age of respondents was 59 years, Most 82.0% had tertiary education, and also, majority (84.7%) and (90.0%) of the respondents had access to extension agents and credit facilities, respectively. The result of the Gini coefficient showed inequality in income distribution with a GI of 0.70 among the respondent. The result of the SUREG showed baiting (67269.73), hive management (410907.1), harvesting and removal of comb (2685.697) and marketing of bee products (14049.11) had a positive influence on the income of beekeepers, while baiting (0.9928245), hive management (1.999738), monitoring of hives (.0399083) and marketing of bee products (.0274556) had a positive influence on the welfare status of beekeepers. The study recommended that beekeeper associations across the study areas and other relevant stakes should intensify training on the efficient use of bee technologies to improve their income and welfare status.

Key words: Adoption; income; welfare; bee hives; technologies

INTRODUCTION

Food and Agriculture Organization ((FAO), 2009) projected that feeding the world population of about 9 billion people in 2050 would require raising overall food production by at least 70%. But the State of Nigeria agriculture and food production, the future challenges and potential solutions require specific agricultural development pathways and technology that must work towards eradicating poverty, hunger and malnutrition in the nearest future (Oladimeji *et al.*, 2015).

Bee keeping is the art and science of raising honeybees for man to benefit economically. According to Tew (2016), there is evidence that humanity first engaged in the activity of beekeeping, also known as apiculture, more than 15,000 years ago. Beekeeping is an enterprise that provides the ability for economically marginalized groups, such as landless poor and rural people, to access income without exacerbating environmental and land tenure problems (Schouten and Lloyd, 2019). Honey bees have great potential to be developed as a smallholder niche industry with low input costs and the ability to scale-up quickly. Bee products can be marketed through existing networks and bees in many cases improve productivity of crop-farming systems through improved pollination.

Beekeeping has evolved to be a very lucrative agricultural practice for local people in developing countries of the world. As an agricultural activity that may generate income all year round under suitable climate conditions of which Nigeria is one of the best country due to its vegetation and weather condition. Apiculture provide more advantages for the producers when compared with other agricultural activities. It can be carried out easily with relatively low capital investment and provides a continuous cash flow into farm budgets since it generates income in a rather shorter period. Apiculture, which is one of the important livestock subsectors, contributes significantly to the improvement of the livelihoods of the nation's population (Aklilu, 2002). Besides production of honey, bees are also kept for sale to other beekeepers and other bee by-products such as beewax, propolis, pollen, and royal jelly (Van Huis, 2013). If the improved beehive technologies are taking into consideration as part of our agricultural activities in Nigeria it will create more job opportunities to the teaming youths and will reduce poverty among rural people. Hence this study investigates the effects of the adoption of improved bee hive technologies on beekeeper's income and welfare status in Ekiti State, Nigeria. Specifically the study aimed to

i. describe the socio-economic characteristics of beekeepers
ii. examined the income distribution among beekeepers and
iii. assess the effects of adoption of improved beehive technologies on farmer's income and welfare status

METHODOLOGY

The study was carried out in Ekiti State, Nigeria. The State is located within the Latitudes 7.621111 and Longitudes of 5.221389. The State covers a total land area of 5887.890 square km. The population of Ekiti State as at 2006 census was 2,384,212 (NPC, 2006), however, with the annual growth rate of 3.6%, the Ekiti State population was projected to be 4,301,374 as at 2020 (National Bureau of Statistics (NBS), 2021). Some of the agricultural products in the state include cash crops (such as cocoa, oil palm, kola nut, plantain, bananas, cashew, citrus, and timber) and arable/food crops are rice, yam, cassava, maize, and cowpea.

Four stage sampling technique was used to select 249 respondents for the study. Primary data were elicited from respondents using semi-structured questionnaire complemented with interview schedule. Data were analyzed using descriptive and inferential statistic. Objective i was achieved using descriptive statistics while objective ii and iii were achieved using Gini coefficient and Seemingly Unrelated Regression (SUREG)

RESULT AND DISCUSSION

Socioeconomic Characteristics of the Respondents

Results in Table 1 revealed that most (31.7%) were within the age 60 years and above with an average age of 59 years. This depicts that beekeepers in the study area were gradually out of their productive age. Also, most (82.0%) of the beekeepers in the study area had tertiary education. This implies that beekeepers in the study area were well-educated which attributed for the higher adoption of beekeeping technologies across the study areas. Table 1 also indicated that majority (89.0%) of beekeepers had beekeeping experience within the range of 1 – 5 years with an average experience of 4 years. More also, majority (84.7%) of the beekeepers had access to extension contact and 90.0% had access to credit

Table 1: Socio-economic characteristics of beekeepers

Variables	Frequency	Percentage	Average
Age			
30 – 39	74	29.72	
40 – 49	52	20.88	
50 – 59	44	17.67	59
>60	79	31.73	
Level of education			
Primary	4	1.61	
Secondary	28	11.24	
Tertiary	203	81.53	
Non-formal	11	4.42	
Others (Quranic)	3	1.20	
Beekeeping experience			
0 -1	98	39.36	
3 – 5	124	49.80	4
6 – 8	27	10.84	
Extension contact	211	84.74	
Access to credit	224	89.96	

Source: Field survey, 2022

Income Distribution among the Beekeepers

The results in Table 2 revealed the calculated Gini-coefficient to be approximately 0.70 which is close to one which implies that there was inequality in the income distribution among the beekeepers in the study area. This could be attributed to under-utilization of adopted beehive technologies and incident of theft which reduce the yields of beekeepers significantly. In addition, lack of centralized marketing system for bee products contributed to the inequality in income among the respondent in the study area.

Table 2: Income distribution among beekeepers

Income range (₦)	Frequency	Proportion of respondents (X)	Cumm. Proportion of incomes (Y)	XY
<60001	3	0.012	0.003	0.000036
60001-120000	11	0.044	0.021	0.000924
120001-180000	42	0.169	0.111	0.018759
180001-240000	97	0.390	0.381	0.14859
240001-300000	82	0.329	0.391	0.128639
>300000	14	0.056	0.093	0.005208
Total	249	1.000	1.000	0.302156
Minimum income	55200			
Maximum income	450000			
GI				0.697844

Source: Field survey, 2022

Effects of Adoption of Improved Beehive Technologies on Farmer's Income and Welfare Status

The results of the SUREG models on the relationship between income and welfare status of beekeepers are presented in Table 3. The non-zero cross-correlation estimated equations error terms, the Breush-Pagan (Chi^2) which is highly significant at the 1% probability level, implies that the use of SUREG is suitable for the two (2) equations. The Root Mean Square Error (RMSE) is used to aggregate the magnitudes of the error. The equations tended towards zero indicating a perfect fit of the model and good at predicting the observed data.

Income model

In the income model, the coefficient for baiting (67269.73) was positive and statistically significant at 5% probability level, which implies that a unit increase in adoption of baiting will increase the income status of the beekeeper. This is because proper baiting is expected to promote the rate of colonization and invariably improve the output. Also, the coefficient for hive management

(410907.1) was positive and statistically significant at 1% probability level. This met the *a priori expectation*. This is because proper hive management is expected to bring about healthy and strong bee colonies that will improve the yields of beekeepers. The coefficient for apiary cleaning (-105769) was negative and statistically significant at 1% probability level, which implies that an increase in apiary cleaning adoption will reduce the income of beekeepers. This negates the *a priori* expectation; this result could be attributed to poor methods utilized in cleaning the apiary, which include using force to open the hive and use of herbicide to control the apiary environment. The coefficient for harvesting and removal of comb (26685.697) was positive and statistically significant at 1% probability level, which implies an increase in harvesting and removal of comb adoption will increase the income of beekeepers. Also, the coefficient for marketing of bee products (14049.11) was positive and spastically significant 10% probability level, which implies that an increase in marketing bee products will increase the income of beekeepers. This met the *a priori. expectation this* is because selling bee products in a well organized marketing system where there is price regulation will significantly improve the income of beekeepers.

Welfare status model,

The coefficient of baiting (0.9928245) was positive and statistically significant at 1% probability level implying that increase in baiting adoption will increase the welfare status of beekeepers. The coefficient of hives management (1.999738) was positive and statistically significant at 1% probability level implying that increase in hives management will leads to increase in welfare status of beekeepers. The coefficient for monitoring of hives (.0399083) was positive and statistically significant at 5% probability level implying that increase in hives monitoring will leads to increase in welfare status of beekeepers. More also, the coefficient for marketing of bee products (.0274556) was positive and spastically significant at 5% probability level, which implies that an increase in marketing bee products will leads to an increase in the welfare status of beekeepers.

Table 3: Effects of adoption of improved beehive technologies on farmers' income and welfare status

	Income			Welfare		
Variables	Coefficient	Standard error	z-values	Coefficient	Standard error	z-values
Baiting	67269.73**	28219.25	2.38	.9928245***	.0961703	10.32
Hive management	410907.1***	90784.01	4.53	1.999738***	.1279804	15.63
Apiary cleaning	-105769***	36834.66	-2.87	.0000872	.0519267	0.00
Monitoring of hives	8442.676	11032.9	0.77	.0399083**	.0183724	2.17
Separation of Honey and combs	-26452.36	44926.14	-0.59	.0000872	.0633334	0.00
Colony multiplication	-33360.12	26164.38	-1.28	-.0124873	.0368845	-0.34
Honey extractor machine	563.4224	10281.18	0.05	.0035529	.0144936	0.25
Harvesting and removal of honey combs	26685.697***	8367.15	3.20	.0000872	.0371704	0.00
Refining honey for packing honey	3964.067	8970.331	0.44	.0161971	.0126457	1.28
Marketing of the by-products and	14049.11*	8244.472	1.70	.0274556**	.013729	2.00
R^2	0.4435			0.3373		
Chi^2	3175.70			281935.25		
$Prob>Chi^2$	0.00			0.00		

Source: Field survey, 2022

Values in parentheses are the z-values. *** P<0.01, **P<0.05 and *P<0.10.

REFERENCES

Aklilu, Y. (2002). An audit of the livestock marketing status in Kenya, Ethiopia and Sudan AU-IBAR (Africa Union Inter African Bureau for Animal Resources), Nairobi, Kenya. 1, (2), 78-82.

FAO. (2009). Bees and their role in forest livelihoods: A guide to the services provided by bees and the sustainable harvesting, processing and marketing of their products by Nicola Bradbear. Global Agriculture towards 2050, Pp. 19- 204.

National Bureau of Statistic (NBS), (2020). Quarterly report. Retrieved from *https://www.nigeria nstat.gov.ng.*

National Population Commission (NPC) (2006). Nigerian Population Census Report. National Population Commission, Abuja, 21-27.

Oladimeji, Y.U., Abdulsalam, Z., Damisa, M.A. & Omokore, D.F. (2015). Estimation of efficiency differentials in artisanal fishery: implications for poverty reduction in selected states in North Central, Nigeria, Nigerian *Journal of Basic and Applied Science*, *23(2), 121- 128.*

Schouten, C. & Lloyd, D. (2019). Considerations and factors influencing the success of beekeeping programmes in developing countries. Bee World,96 (3) 75-80.

Tew, J. E. (2016). Bee yard Thoughts. Bee Culture of Science and Technology 144(1), 37-40. , 3, 7–11.

Van-Huis, A. (2013). Potential of insects as food and feed in assuring food security. *Annual Review of Entomology*, 58(1), 563–583.

12 ASSESSMENT OF OUT-MIGRATION AMONG ARABLE CROP FARMERS IN KOGI STATE, NIGERIA: GENDER DYNAMIC APPROACH

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Sub-theme: Extension service delivery for climate smart agriculture

ABSTRACT
The study assessed out-migration among arable crop farmers in Kogi State, Nigeria: Gender dynamic approach. *Multi stage Sampling technique was used to select 217 households comprising of 137 male and 80 female-headed households. Primary data were collected with aid of semi-structured questionnaire complimented with an interview schedule and analyzed using descriptive statistics. The results obtained showed that most (male 60.6% and female 55.0%) of the households were in their middle age between 31 – 50 years with mean ages of 47 and 48 years, respectively. The mean farm size for the male and female headed households were 2.5 and 1.5 hectares, respectively. The female headed households (18.7%) had less access to extension services as compared to the male headed household (30.7%). Out-migration is common to both households as the male (39.4%) and female (43.8%) headed households indicated moderate level of out-migration. Major reason for out-migration as indicated by the male (57.7%) and female (60.0%) headed households was for remittances back home. Meanwhile, the strategies adopted by the households to mitigate the effect of out-migration include among others engaging in community activities ($\bar{X}$ = 2.62), application of modern farming technologies ($\bar{X}$ = 2.55) and development of entrepreneurial skills ($\bar{X}$ = 2.50) ranked 1st, 2nd and 3rd, respectively. All factors enumerated were perceived to have significant influence on out-migration with lack of social amenities ($\bar{X}$ = 2.96), problem of unemployment ($\bar{X}$ = 2.95) and poverty ($\bar{X}$ = 2.80) ranked top most. Therefore, the study recommended that Government and other funding organizations should promote skills acquisition and provide infrastructural facilities among household along gender dynamics to cushion the effects of out-migration particularly in the study area.*
Keywords: Out-migration, arable crop, farmer, gender, dynamics

INTRODUCTION
Agriculture has been the major source of livelihood of the rural people in most African communities including Nigeria. The importance of agricultural sector in the overall Nigerian economy cannot be over-emphasized. Agriculture remains the key sector in the rural areas of Nigeria where over 70% of its population reside. Agriculture contributes about 27.68% to the Gross Domestic Products (GDP) and provides livelihood for about 70% of the population (National Bureau of Statistics (NBS), 2017). As a leading contributor to household food supply and other natural resources, agriculture is affected by out-migration along gender dynamics, particularly in the area of sustainable arable crop production.

Movement of people from place to place has been a recurrent decimal phenomenon since the era of human history (Ibrahim and Danjunma, 2012). However, its form has changed but it remains a very dominant issue in the global social system. In recent time, people migrate from under-developed areas to the developed ones in search of better employment and opportunities. Thus, surplus labour from low productive agriculture in rural areas is transferred to high industrial areas (Liu *et al.*, 2016). The drastic decrease in rural labour due rural-urban migration has led to reduction in total cropped area and output giving rise to reduced food production in the rural areas. The impoverishment of rural areas in Nigeria is partly explained by economic isolation and out-migration of youths in search of employment in cities, which affects the labour force for agricultural production, with males more proned to migration than females (Ofuoku, 2015). Out-migration leads to labour shortage and decline in the average quality of labour which adversely affects output and productivity in native places. The new economics of out-migration explains that the decision to migrate is taken by larger association of related people, households or families rather than autonomous individuals (Liu *et al.*, 2016).

According to Fasoranti (2019), out- migration has become of utmost importance as it impact both place of origin and destination. Though out-migration is not limited to a particular group yet the effects is significantly noticed on the agricultural activities and household livelihood. Meanwhile, there are far reaching consequences of out-migration on demand for labour force in place of origin. Keeping in view the anticipated consequences of out-migration in place of origin, this study was undertaken to examine the effects of out-migration along gender dynamics on arable crop production and households' livelihood.

López-Carr and Burgdorfer (2013) posited that various researchers have seen out-migration as setback to increase arable crop production arguing that even with increase in technology able-bodies men and women are needed to drive those technologies. Hence, development should involve empowering rural population mostly women to engage in sustainable means of livelihood such as crop farming and aquaculture (Nwabueze, 2010). In view of the foregoing, the study therefore sought to assess out-migration among arable crop farmers in Kogi State, Nigeria. Specifically, the study described the socio-economic characteristics of the arable crop farming households along gender dynamics: examine the level of out-migration; assess perceived factors influencing out-migration and examine strategies adopted to mitigate the effects of out-migration along gender dynamics.

METHODOLOGY

Study Area

The study was conducted in Kogi State which is located in the North central region of Nigeria. Kogi state is popularly called the Confluence State owing to the confluence of River Niger and Benue at the capital in Lokoja. It is located between Latitude $7^0 48^1$ and $8^0 35^1$ North and Longitude $6^0 44^1$and $7^0 49^1$ East. It has a land mass of 30,354.74 square kilometers (11,519 square miles) with population of about 3,278,487 people according to the 2006 National census (Sunday, 2014). However, with a growth rate of 3.2%, the population was projected to 4,636,071 in 2017 (National Bureau of Statistics (NBS), 2017).

The State comprises of twenty-one (21) Local Government Areas (LGAs) divided into four Agricultural zones. The State experience two distinct seasons, wet and dry. The wet season begins in March and ends in October while the dry season spans between November and early March. The annual rainfall is between 1016mm and 1524mm, while the mean daily temperature ranges from 24^0C and 27^0C (NBS, 2018). Kogi State has a wide stretch of Forest and arable land for farming, good grazing land for livestock production and large bodies of water for fishing and irrigation. Food and cash crops commonly grown in commercial quantities include yam, cassava, rice, maize, beni-seed (Sesame) guinea corn, cashew, oil palm and vegetables.

Sampling Procedure and Sample Size

Multi-stage sampling procedure was adopted for this study. The first stage was the selection of one Local Government Area (LGA) from each of the agricultural zones to get four LGAs. The second stage was the random selection of one extension block from each of the selected LGAs to get four extension blocks. The third stage was the selection of three extension cells which gave 12 villages. Stage four involved stratification of the registered rural households (2,169) in the study area as obtained from Kogi State Agricultural Development Programme (KADP) into male (1,367) and female (802) headed households. The final stage was the proportionate sampling of the rural households using 10% which produced sample size of 137 male and 80 female headed households and grand total of 217 respondents.

Method of Data Collection

Primary data were used for this study which was collected using semi-structured questionnaire complemented with interview schedule. Information obtained from the rural households include socio-economics characteristics, household out-migration, factors influencing out-migration and the mitigating strategies adopted to ameliorate out-migration.

Method of Data Analysis

Data collected were analyzed using descriptive statistics such as frequency count, percentages and means scores. However, 3-point Likert rating type scale was used to measure respondents' perception on the factors influencing out-migration and strategies adopted to mitigate the effects of out–migration on arable crop production. Level of out-migration was categorized based on the number of household out-migrants such as < 3 (low level), 3 – 5 (moderate level) and > 5 (high level).

RESULTS AND DISCUSSION

Socio-economic characteristics of the respondents

As revealed in Table 1, about 32.1% of the male household heads and 45.0% of the female household heads were within the age bracket of 41 – 60 years with mean ages of 47 and 48 years, respectively. This implies that the respondents in the study area were in their middle age but still in their productive stage of life. Majority (92.1%) of the male were married, while 75% of the female-headed household were widowed. This indicate that the respondents particularly the female households had much responsibility to handle as widows hence will embrace various coping strategies especially household migration. This is in corroboration with the findings of Egwu *et al.* (2008) who reported that married individual play active role in agricultural production based on poverty levels. The study further revealed that most (46.4% of the male headed households and 38.8% of the female headed household) had acquired secondary education as a formal schooling. Education help to liberate individuals from ignorant implying that gender had certain level of education that could assist them in making an informed decision in order to have a better livelihood.

More so, Table 1 revealed that 37.2% of the male and 41.3% of the female headed households had farming experience of between 11-20 years with a mean of 17 years respectively. This implies that gender engaged in farming activities are experienced in arable crop production. This is in corroboration with the finding of Rubin and Manfre (2012) who reported that stated that women contribute more than half of the food produced in developing countries. Most (67.7%) of the male and 45.7% of the female headed households had household size of less than 6 persons with a mean household size of 5 and 4 persons, respectively. This implies that both gender had a fairly large family thus the need to seek various coping strategies including out-migration to cope with family expenditure.

Table 1 revealed that the majority (83.9% and 96.3%) of the male and female headed households had farm size of less than three hectares with a mean value of 2.5 and 1.5 hectares, respectively. This implies that both genders were small-scale farmers with the male having more access to land than their female counterpart. This study is in corroboration with the findings of Sharon (2008) that rural women were highly disadvantaged in with respect to the ownership and control of assets such as land. Also, most (57.7%) of the male headed households were member of cooperative societies, while 42.5% of the female headed households were member of cooperative societies. This implies that both genders belong to one cooperative group or the other, which can better their living standard. Thus, cooperative membership could bring in a lot of benefits to rural farmers.

Also, most (69.3%) of the male and 81.3% of the female-headed households had no extension contact. This implies that there was poor contact with extension agents as majority had no contact. However, among those that had extension contact, the number of male were higher than the female. Contact with extension agent usually exposes farmers to innovations for improved production. This is in line with the finding of FAO (2017) who reported that it was a common practice to direct extension and training services primarily towards men. Furthermore, 33.6% of the male and 31.3% of the female headed households had access to credit. This implies that there was poor access to credit facilities among the gender with the male having more access to credit than the female. Access to credit facilitates adoption of technology among rural households. The results also corroborate the finding of FAO (2017) that male had more access to credit than their female counterpart.

Table 1: Distribution of respondents based on their socio-economic characteristics

Variables	Male (n = 137)		Female (n = 80)	
	Frequency	Percentage	Frequency	Percentage
Age(years)				
< 21	13	9.50	8	10.00
21-30	30	21.90	6	7.50
31-40	39	28.50	8	10.00
41-50	44	32.10	36	45.00
51-60	11	8.00	22	27.50
Mean	47		48	
Marital status				
Single	6	4.40	4	5.00
Married	125	91.20	6	7.50
Divorced	4	2.90	10	12.50
Widowed	2	1.50	60	75.00
Education status				
Primary	24	17.50	22	27.50
Secondary	61	44.50	31	38.80
Tertiary	41	29.90	15	18.70
Non-formal	11	8.10	12	15.00
Mean	12		10	
Farming experience (years)				
< 11	48	35.00	23	28.75
11-20	51	37.30	33	41.25
21-30	24	17.50	17	21.25
> 40	14	10.20	7	8.75
Mean	17		17	
Household size (Number)				
< 6	93	67.90	42	52.50
6-10	38	27.70	38	47.50
> 11	6	4.4	-	-
Mean	5		4	
Farm size (Hectares)				
< 3.1	115	83.90	77	96.30
3.1-5.0	12	8.80	3	3.70
> 5.0	10	7.30	-	-
Mean	2.5		1.5	
Cooperative membership				
Yes	79	57.70	34	42.50
No	58	42.30	46	57.50
Extension contact				
Yes	42	30.70	15	18.70
No	95	69.30	65	81.30
Access to credit				
Yes	46	33.60	25	31.25
No	91	66.40	55	68.25

Source: Field Survey, 2021

Level of out-migration among the respondents

Table 2 shows that both male (43.8%) and female (50.0%) headed households indicated both gender were involved in out-migration. This finding agrees with that of Ofuoku (2015) who reported that with growing social acceptance of female independence and mobility, girls and women are now the majority of Ghana's internal migrants. Most out-migrants leave their community majorly in pursue of education as indicated by male (42.3%) and female (35.0%) headed households. This substantiates the finding of Afolayan (2008) who reported that the search for Western and Islamic education has induced quite a lot of migration. Most (67.2% of male and 58.8% female) of the households revealed that out-migration is mostly from rural to urban area in anticipation for better opportunities. This is in line with the findings of Ibrahim and Danjumoh (2012) who found most migrations to be toward the urban centres where better livelihood are abounds. The out-migrants contribute toward their origin in terms of remittance as indicated by 57.7% of male and 60.0% of female- headed households. This agrees with the finding of FAO (2016) that most migrants contribute to their home through remittances.

Table 2: Distribution of respondents based on out-migrants

Variables	Male (n = 137)		Female (n = 80)	
	Frequency	Percentage	Frequency	Percentage
Gender of household migrants				
Male	56	40.9	23	28.7
Female	21	15.3	33	41.3
Both	60	43.8	24	30.0
Reason for out-migration				
Education	58	42.3	28	35.0
Government employment	20	14.6	13	16.3
Health challenges	-	-	21	26.2
Private worker	21	15.3	2	2.5
Apprenticeship	9	6.6	6	7.5
Wage labour	29	21.2	10	12.5
Pattern of out-migration				
Rural-rural	33	24.1	17	21.3
Rural-urban	92	67.1	47	58.7
Seasonal	12	8.8	12	15.0
Permanent	-	-	4	5.0
Contribution of out-migrants				
Remittance	79	57.7	48	60.0
Modern technologies	20	14.6	9	11.3
Information sources	38	27.7	23	28.7

Source: Field Survey, 2021

As revealed in Table 3, more than half (51.8%) of the male and 50.0% of the female headed households indicated low level of out-migration, while 39.4% of the male and 43.8% of the female headed households indicated moderate level of out-migration. This implies that there was low to moderate level of out-migration in the study area which could become necessary in order to attract favourable opportunities lacking in the rural areas.

Table 3: Distribution of respondents based on level of household out-migrants

Variables	Male (n = 137)		Female (n = 80)	
	Frequency	Percentage	Frequency	Percentage
Low	71	51.80	40	50.00
Moderate	54	39.40	35	43.80
High	12	8.80	5	6.20

Source: Field Survey, 2021

Strategies adopted to mitigate out-migration by the respondents

Table 4 show the strategies adopted by the male-headed households include application of modern farming technologies ($\bar{X}$ = 2.66), development of entrepreneur skill ($\bar{X}$ = 2.56) and engagement in community activities ($\bar{X}$ = 2.49) ranked 1st, 2nd and 3rd, respectively. Also, the female-headed households adopted strategies include engagement in community activities ($\bar{X}$ = 2.62), application of modern farming technologies ($\bar{X}$ = 2.55) and development of entrepreneur skill ($\bar{X}$ = 2.50) ranked 1st, 2nd and 3rd, respectively. This implies that the rural households adopt several strategies to mitigate out-migration which help them to achieve improved livelihood. This agrees with the finding of Beegle and Poulin (2013) who posited that out-migration enhances progress and foster better livelihood.

Table 4: Distribution of respondents' based on strategies adopted to mitigate out-migration

Variables	Female (n=80)				Male (n=137)			
	WS	WM	Decision	R	WS	WM	Decision	R
Engagement in community activities	210	2.62	Adopted	1st	341	2.49	Adopted	3rd
Application of modern farming technologies	204	2.55	Adopted	2nd	364	2.66	Adopted	1st
Development of entrepreneur skill	200	2.50	Adopted	3rd	351	2.56	Adopted	2nd
Reduced area of land cultivated	201	2.51	adopted	4th	323	2.36	Adopted	5th
Market development and services provision	196	2.45	Adopted	5th	334	2.44	Adopted	4th
Practicing of communal farming	158	1.98	Not Adopted	6th	267	1.95	Not Adopted	6th

Source: Field Survey, 2021

Note: WS = Weighted Sum, WM = Weighted Mean, R = Rank & Bench Mean Score = 2.0

Perceived factors influencing out-migration by the respondents

Table 5 revealed the perceived factors influencing out-migration in the study area. All the factors enumerated were perceived to influence out-migration for both gender. However, the male-headed households indicated problem of unemployment ($\bar{X}$ = 2.86), problem of poverty ($\bar{X}$ = 2.80) and inadequate social amenities ($\bar{X}$ = 2.79) ranked 1st, 2nd and 3rd as the major factors. Also, the female-headed households perceived inadequate social amenities ($\bar{X}$ = 2.96), problem of unemployment ($\bar{X}$ = 2.95) and problem of poverty ($\bar{X}$ = 2.80) ranked 1st, 2nd and 3rd, respectively as the major factors influencing out-migration. This implies that several factors influences the quest for a better living standard which is a major driver for out-migration. This finding is in agreement with that of FAO (2016) that major driver for out-migration is economy reasons.

Table 5: Distribution of respondents based on perceived factors influencing out-migration

	Female (n = 80)				Male (n = 137)			
Variables	WS	WM	Decision	Rank	WS	WM	Decision	Rank
Lack of social amenities	237	2.96	SI	1st	382	2.79	SI	3rd
Problem of unemployment	236	2.95	SI	2nd	392	2.86	SI	1st
Problem of poverty	224	2.80	SI	3rd	384	2.80	SI	2nd
Problem of safety and insecurity	218	2.72	SI	4th	360	2.63	SI	4th
Crop failure	209	2.61	SI	5th	332	2.42	SI	7th
Community crisis	208	2.60	SI	6th	333	2.43	SI	6th
Problem of potential for employment	198	2.47	SI	7th	335	2.45	SI	5th
Attractive climatic environment	190	2.38	SI	8th	306	2.23	SI	11th
Attractive quality of life	190	2.38	SI	8th	319	2.33	SI	8th
Political instability	188	2.35	SI	10th	295	2.15	SI	14th
Problem of drought and flooding	187	2.34	SI	11th	315	2.30	SI	9th
Farmland infertility	184	2.30	SI	12th	311	2.27	SI	10th
Safer atmosphere	173	2.16	SI	13th	304	2.22	SI	12th
Less risk of natural Hazard	171	2.14	SI	14th	295	2.15	SI	14th
Low crime rate	171	2.14	SI	14th	296	2.16	SI	13th

Source: Field Survey, 2021

Note: SI = Significant Influence, WS = Weighted Sum, WM = Weighted Mean, Bench Mean Score = 2.0

CONCLUSION AND RECOMMENDATIONS

The research showed that farmers of both genders are in their mid-age but still active, they have migrants from their various household. The findings showed factors that encourages out-migration to include unemployment, insufficient social amenities and conflicts. The strategies employed by the respondents to militate out-migration are adoption of modern farming technologies, promotion on community conflict resolution and development of market and services. The result shows both genders had migrants. The following recommendations were proffered: Government and funding partners should step up social amenities delivering agency specifically for rural areas. Also, entrepreneurship skills should be highly promoted among households by relevant stakeholders along gender dynamics and good marketing network is a key to mitigating out-migration.

REFERENCES

Beegle, K. and Poulin, M. (2013). Migration and the transition to adulthood in contemporary Malawi. *Annals of the American Academy of Political and Social Science,* 648 (1), 38 – 51.

Donato, K. M. and Gabaccia, D. (2015). *Gender and International Migration*. New York: Russell Sage Foundation, Pp 22

Food and Agriculture Organization (FAO) (2016). Gender, Key to Sustainability and Food Security. Plan of Action. Gender and Development, Rome.

Food and Agriculture Organization (FAO) (2017). Challenges and Opportunities for Equal Participation of Women and Girls in Rural Development in Georgia. Rome, Italy.

Fasoranti, O. O. (2019). Perception of rural-urban migration of selected rural communities in Ondo State, Nigeria. *Bangladesh e-journal of Sociology*, 6 (1), 96 – 105.

Ibrahim, S. K. and Danjuma A. (2012). Effects of migration of farmers on sustainable livelihood in Nigeria. *Journal of Business and Management*, 4 (3), 10 – 14.

Liu, X., Lehtonen, H., Purola, T., Pavlova, Y., Rotter, R. and Palosuo, T. (2016). Dynamic economic modelling of crop rotations with farm management practices under future pest pressure. *Journal of Agricultural System*, 144, 65 –76.

Lopez-carr, D. and Burgdorfer, J. (2013). Deforestation drivers: population, migration and tropical land use. *Journal of Environmental Science and Policy for Sustainable Development*, 55, 1 – 21.

Meyer, F. (2018). Navigating aspirations and expectations: Adolescents' considerations of out-migration from Rural Eastern Germany. *Journal of Ethnic and Migration Studies*, 44 (6), 1032 – 1049.

National Bureau of Statistics (NBS) (2017). Sustainable Development Goals (SDGs) Indicators Baseline Report 2016. Federal Capital Territory (FCT), Abuja, Nigeria.

National Bureau of Statistics (NBS) (2018). Nigerian Gross Domestic Product Report. Abuja, Nigeria, Pp 89.

National Population Commission (NPC), (2006). Provisional Census figure of Nigeria: How many we are NPC/FGN, Abuja, Pp 18.

Nwabueze, A. A. (2010). The role of women in sustainable aquacultural development in Delta State. *African Journal of Agricultural Research and Development*, 3 (3), 11 – 16.

Ofuoku, A. U. (2015). Effect of rural-urban migrants' remittances on arable crop production in Delta State, Nigeria. *Journal of Agricultural Sciences*, 60 (1), 49 – 59.

Olawepo, R. A. (2010). Determining rural farmers' income: A rural Nigeria experience. *Journal of African Studies and Development*, 2 (4), 99 – 108.

Rubin, D. and Manfre, C. (2012). Applying gender-Responsive Value-Chain Analysis in Extension and Advisory Services. Modernizing Extension and Advisory Services Technical Note. US Agency for International Development, Washington, DC.

Sunday, E. O. (2014). Trip down memory lane: Ebira people, the most outspoken talented and hardworking people of Kogi State in Nigeria.

13 THE EFFECT OF AGRITECH STARTUPS ON PARTICIPATION AND POVERTY STATUS OF ADOPTERS IN OGUN STATE, NIGERIA

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Abstract

This research focused on soilless farming technology. The study compared the adopters and non-adopters of the technology, evaluating the effect of Agritech startups on participation and on poverty status of farmers in Ogun state, Nigeria. Primary data were obtained from 130 farmers, this number includes 50 adopters and 80 non-adopters of the technology. A well- structured questionnaire was used. Descriptive statistics, Foster-Greer-Thorbecke (FGT), Total factor productivity, and Logit regression model was used to analyze the data collected. The results revealed that the Agritech startup positively and significantly contributes to participation of farmers in agriculture. The results showed that the adopters were made up of young, educated farmers who recently ventured into farming and were fully aware of the technology. On the contrary, majority of the non-adopters were old, with less formal education and were not aware of the technology. Results of the FGT Poverty index revealed that 16% and 81.3% of the adopters and non-adopters were poor and living below the poverty line, respectively. In addition, age, education, and poverty status were the factors that influence farmers' adoption of the technology.

Keywords: Agritechnology: participation; poverty; adopters; Nigeria.

Introduction

Nigeria's agriculture has had several challenges since the 1970's, which have led to low yields and post-harvest losses. Small-scale farmers have a number of challenges, such as restricted access to land, slow adoption of technologies, a lack of storage space, an excessive reliance on rain-fed irrigation, and poor market access. Due to high costs of low-quality inputs and restricted access to financing facilities, agricultural productivity is low when compared to other countries. (Groupe Speciale Mobile Association, 2020).

Because of these challenges, Nigerians, especially the young ones have become deterred from engaging in agriculture, which has raised the unemployment rate. One of the main factors contributing to poverty is unemployment. Nearly 40% of Nigeria's 200 million inhabitants, or roughly 86.9 million people, are believed to be living in absolute poverty (Sustainability, 2021).

Agritech startups have increased significantly during the past few years. This Agritech businesses have been offering online solutions to Nigerian smallholder farmers who are struggling. They supervise farmer's progress from the start of Agricultural season till harvest, offering solutions that enhance farming techniques and introducing the best practices. Farmers can now enter the market, thanks to the new digital technologies that connect the market with buyers of their produce, Numerous Agritech companies are currently based in Nigeria. Like Soilless Farm Lab, FarmCrowdy, HelloTractor, Thrive Agric, AgroMall and a plethora of more businesses. In Nigeria, agriculture continues to be the largest industry, accounting for an average of 24% of the country's GDP for the previous eight years (2013-2020).

Additionally, the sector employs more than 36% of the workforce in the nation, making it the biggest employer of labor in the nation. Growth in the agricultural sector is at least twice as effective as growth in other economic sectors at reducing poverty and increasing income for the most vulnerable.

This research therefore assesses the effect of Agritech startups on participation in Agricultural activities and poverty status of adopters in Nigeria, focusing mainly on Soilless farming technology

Materials and Methods

This study was carried out in Ogun State, South-Western Nigeria. The State was created in February 1916 from the former Western State. Abeokuta is the capital city of Ogun State. Other notable cities in the State include Sagamu, Ijebu-ode, (The previous capital of Ijebu kingdom). It is covered predominantly by tropical rainforest and has a wood savanna in the north-west (Wikipedia, 2006). Agriculture is the economic mainstay of Ogun State. It produces cassava, yam, plantain, and Banana. The main cash crops produce is cocoa, kolanut, rubber, palm oil, tobacco, cotton, tuber, and palm kernel (Britannica, 2018). Ogun State is home to many AgriTech companies; Soilless Farm Lab, Groupfarma, Xtralarge farms, Farmcrowdy, Farmkart, Farmnow and many others (Britannica, 2018).

Sampling Techniques and Sample Size

The population of this study comprised of some farmers in the area. A reasonable number of about one hundred and thirty (130) farmers was selected randomly in the study area. This number includes 50 adopters and 80 non-adopters of the technology. Data was gathered through primary means to the respondents. The selection of samples was determined by the data that was provided by Soilless Farm Lab. A total number of 130 farmers was interviewed from the selected area.

Method of Data Collection

Well-structured questionnaire, consisting of open and close ended questions with personal interview design covered the aspects of production, resources, inputs, interest, perception about the technology, and socioeconomic characteristics.

Analytical Techniques

Descriptive statistics was used to determine the level of adoption. Total Factor Productivity (TFP) was used to measure the productivity of the respondents. Foster, Greer and Thorbecke (FGT) index and Logit regression were used to measure the poverty status of respondents and also to analyze the factors that influence farmers' adoption of soilless farming technology in the study area.

Results and Discussion

The results of the study revealed that the ages of the respondents range from 25 to 66 with a mean of 32.54 and 52.14 for adopters and non-adopters respectively. This shows that both the young and the old are involved in farming. The study revealed that 98% of the adopters have attained tertiary education, while only 17.5% of the non-adopters have tertiary education. The average years of experience were 4.12 and 31.69 for adopters and non-adopters respectively. Adopters had 100% level of technological awareness while non-adopters had only 10%.

Table 1: The evel of adoption of Soilless Farming Technology among Adopters in the study area

Soilless Farming Methods	Adoption Status	Percentage Adoption
Hydroponics	Yes	50
Aeroponics	No	50
Total	50	100

Source: Field Survey, (2022)

Table 2: Hydroponics

Adoption status	Frequency	Percentage
Yes	50	100.0

Source: Field Survey, (2022)

Table 3: Aeroponics

Adoption status	Frequency	Percentage
No	50	100.0

Source: Field Survey, (2022)

The tables above (Table 1,2 &3) show the result of the level of adoption of the soilless farming technology. 100 percent of the adopters have adopted the Hydroponics farming system. On the other hand, 100 percent of the adopters have not adopted the Aeroponics farming system. This indicates that only Hydroponics soilless farming system has been adopted while Aeroponics has not been adopted in the study area. Hence, the adoption of soilless farming system is only 50 percent. This shows that soilless farming system is yet to be fully adopted.

Awareness of Soilless Farming Technology

Table 4: Distribution of Respondents by awareness of Soilless Farming Technology

	Adopters of Soilless Farming Technology		Non-adopters of Soilless Farming Technology	
	Frequency	Percentage	Frequency	Percentage
Awareness of Soilless Farming Technology Aware	50	100.0	8	10.0
Not aware	0	0.0	72	90.0
Source of Information about Soilless Farming Technology Friends	24	48.0	1	12.5
Mass media	6	12.0	7	87.5
Family	20	40.0		
Total	50	100.0	8	100.0

Source: Field Survey, (2022)

The level of awareness of Soilless Farming Technology by the respondents is presented in Table 4. The table shows that the level of awareness of the technology is low among the respondents, with a 100% level of awareness for adopters and 10% for non-adopters. 48% of the respondents got the information from friends as against 12.5% of the non-adopters who were aware of the technology. 12% of the adopters sourced their information from the mass-media as compared to 87.5% of the non-adopters. Also, 40% of the adopters were aware of the technology through family. These results indicate that friends and mass media are important sources of information on agricultural innovations.

Table 5: Percentage distribution of productivity indices of the respondents

Indices	Adopters of Soilless Farming Technology		Non-adopters of soilless farming Technology	
	Frequency	Percentage	Frequency	Percentage
<=.010000	42	92.0	58	72.5
.010000 - .060000	4	8.0	20	25
.060000+			2	2.5
Total	50	100.0	80	100.0

Source: Field Survey, (2022)

Table 6: Total Factor Productivity of the respondents

Total Factor Productivity	N	Minimum	Maximum	Mean	Std. Deviation
Adopters	50	.002290	.018875	.00483618	.003453177
Non-adopters	80	.000212	.067308	.01073490	.013820868

Source: Field Survey, (2022)

From table 5&6, it can be seen that 92% of the adopters have the total factor productivity <=.010000 as against 72.5% of the non-adopters. The TFP of 8% of the adopters falls between .010000 and .060000 as against 25% of the non-adopters. Also, in table 5, 2.5% of the non-adopters have their TFP greater .06000. The mean of the TFP of adopters is .00483618 while that of the non-adopters is .01073490. These results indicate that the productivity of non-adopters is slightly higher than that of adopters.

This can be caused by different factors such as:

- High Input cost: The total cost of input used by adopters is higher when compared to that of non-adopters. The tables below (7&8) help to explain this better.

Table 7: Total Input cost of the respondents

Total cost of input (In Naira)	N	Minimum	Maximum	Mean	Std. Deviation
Adopters	50	470000	19260000	10705740.00	5862867.641
Non-adopters	80	161000	12000000	2292578.38	2771236.948

Source: Field Survey, (2022)

Table 8: Total output produced by the respondents

Total quantity produced (In kg)	N	Minimum	Maximum	Mean	Std. Deviation
Adopters	50	5000	70000.00	37640.0000	17229.44798
Non-adopters	80	254.25	70000.00	30922.3294	102989.71079

Source: Field Survey, (2022)

The table shows that the mean cost of input for adopters is NGN10705740.00, this is far higher than that of the non-adopters, which is NGN2292578.38. The mean of output for non-adopters is 30922.3294kg. Despite the amount of money spent on input by adopters, the mean of output is 37640.0000kg, which is slightly higher than that of non-adopters. Marginally, the productivity of adopters is not higher than that of non-adopters.

- Initial cost of investment: In spite of how profitable soilless farming can be, it is capital intensive, especially for people who want to go on large scale production. The amount of capital required to venture into soilless farming technology is high when compared to that of traditional farming. This indicates that high cost of equipment investments causes a decrease in total factor productivity. This is supported by the reports of Sakellaris (2004) and Hugget and Ospina (2001) that total factor productivity drops sharply after adopting new technologies due to the adjustment cost, but it starts to recover afterwards.

- Partial adoption: From the results, it has been shown that adopters are yet to fully adopt the technology. Adopters of the technology are mainly practicing hydroponics. A combination of hydroponics and Aeroponics will help them to maximize their input in order to realize more income, thereby increasing their productivity.

Table 9: Estimated FGT Indices of the Respondents

FGT Indices	Adopters	Non-adopters
Poverty Incidence (P_0)	0.967062	0.735549
Poverty depth (P_1)	0.936623	0.612075
Poverty severity (P_2)	0.908328	0.542116
Mean Per Capital Household Expenditure (NGN)	112,049.336	112,049.336
Poverty Line (NGN)	74,669.557	74,669.557

Source: Field Survey, (2022)

FGT Indices was used to determine the poverty status of the respondents. The result in Table 9 shows that the mean per capital expenditure of the respondents was NGN112,049.336; the poverty line was constructed as two-third of the Mean Per Capital Expenditure (MPCHE), which was estimated as NGN74,669.557, thereby classifying the households into poor and non-poor. The study showed that only 16% of the adopters were poor as against 81.25% of the non-adopters.

Table 10: Determinants of Adoption of Soilless Farming Technology

Variables	Coefficient	Standard error	P-values(p>z)
Age	-1.134	0.537	0.035*
Education (years)	3.414	1.730	0.049*
Poverty status	12.198	5.830	0.036*
Marital status	4.672	5.225	0.371
Primary occupation	5.778	3.546	0.103
Household Decision Maker	-1.735	2.551	0.409
Constant	-23.330	22.199	0.293

Number of observations = 129
LR $chi^2(6)$ = 164.97
Prob >chi^2 = 0.000
Pseudo R^2= 0.9577
**Significant at 5%

Logit regression was adopted to analyze the factors that influence the adoption of the technology.

Result of the analysis (Table 10) showed that out of six variables, only three were significant which includes age, education (years) and poverty status.
Age has a negative coefficient and it is significant at 5% level. This shows that the older the farmer gets, the less likely he is to adopt the technology. Education has a positive coefficient and it is significant at 5% level. This indicates that the higher the level of education, the higher the chances of adoption. Poverty status also has a positive coefficient and it is significant at 5% level. This shows that the poorer a farmer is, the higher his chances of adoption. A poor farmer who wants to escape poverty is more likely to adopt the technology.

Conclusion

From the findings of the study, it can be concluded that the adoption of soilless farming technology has a significant and positive effect on the poverty status of adopters in Ogun state. The Agritech startup has also helped to increase participation of people; especially the youths in agriculture, as majority of the adopters are young people who recently ventured into farming.

The poverty line showed that the number of poor farming households of non-adopters below the poverty line was high. The productivity of non-adopters is higher than that of adopters.

The level of awareness of soilless farming technology is low. The adoption of soilless farming technology is partial.

The significant determinants of adoption are age, education (years) and poverty status.

References

Britannica, T. Editors of Encyclopedia (2018, January 16). Ogun. *Encyclopedia Britannica.* https://www.britannica.com/place/Ogun-state-Nigeria.

Groupe Speciale Mobile Association (GSMA, 2020). *AgriTech in Nigeria. AgriTech in Nigeria; investment opportunities and challenges.*https://www.gsma.com/mobilefordevelopment/resources/agritech-in-nigeria-investment-oppurtunities-and-challenges/

Hugget, Mark, Ospina & Sandra. (2001). *Does productivity growth fall after the adoption of new technology?* https://doi.org/10.36812/page.202127126-42

Mark, H & Sandra, O. (2001). *Does productivity growth fall after the adoption of new technology?* https://doi.org/10.1016/S0304-3932(01)00065-4.

Mfonobong, D. (2022). *The top 10 best agritech companies in Nigeria.* Nigerian Infopedia. https://nigerianinfopedia.com.ng/best-agritech-companies-in-nigeria/

National Bureau of Statistics (2020). *Poverty and inequality in Nigeria:* www.nigerianstat.gov.ng.

Ogun state (2006). In Wikipedia. Retrieved October, 27 2021 from: https://m.wikipedia.org/wiki/Ogun_State.

Phitarchos, S. & Daniel, W. (2004). *Quantifying embodied technological change.* http://dx.doi.org/10.1016/S1094-2025(03)00052-8

Sustainability *(2021). Youth participation in agriculture and poverty reduction in Nigeria.* https://doi.ng/10.3390/su13095172.

World Bank (2018). *Five new insights on how agriculture can help reduce poverty* World Bank Blogs. https://blogs.worldbank.org/jobs/five-new-insights-how-agriculture-can-help-reduce-poverty.

OUTCOMES OF WORK-FAMILY CONFLICT AMONG UNIVERSITY EMPLOYEES: CORRELATES OF TIME, STRAIN AND JOB SATISFACTION

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Abstract

*The recent waves of COVID-19 have brought about a phenomenon shift which suggest family structure moving from traditional-single income family to a double-income family, hence this allows couple to play multiple role such as employee, a spouse, father, mother and housework handler. However, it is more to bring role-conflict caused by limited time and vigour. This study assessed the outcomes of work-family conflict among University employees when Strain-Based Conflict (SBC), Time-Based Conflict (TBC) and job satisfaction are correlated. Multistage sampling procedure was used to select 107 employees for the study. Primary data were obtained using a structured questionnaire and analysed using frequency counts, percentages, mean, Pearson Product Moment Correlation (PPMC), Principal Component Analysis (PCA) and hierarchical regression. Results indicate that the mean age and work experience of the employees were 43.53 and 12.00 years respectively. About 50.54% of the employees were married and 57.90% were non-teaching employee. Correlation analysis revealed that age (-0.286**) and marital status (-0.318**) were negatively correlated while SBC (0.429**) and TBC (0.493*) were positively correlated with Work-Family Conflict. The exploratory PCA shows that three (3) items loading at ±0.70 and above accounted for 62.81% variability of the outcomes of WFC. The regression result revealed a significant association between SBC (t=4.37, p<0.05), TBC (t=3.37, p<0.05) and WFC. It was concluded that there was a positive correlation between strain, time and WFC. Based on this, the study recommends that work-family support from supervisor could help employees reduce their WFC and priorities should be given to practices such as parental leave, domestic leave, and flexible work in order to reduce the outcomes of WFC.*

Keywords: Work-Family Conflict, SBC, TBC, Job Satisfaction, Employees

Introduction

Over the years, most of the studies on Work-Family Conflict (WFC) have been conducted primarily in the western industrialized countries. However, the increase in number of male and female employees in non-western societies particularly Africa joining the workforce calls for attention and have become increasingly important to study. The recent wave of COVID-19 have made WFC increasingly essential in developing nations, the high level of female employees in the work force and their increased educational status have recently changed the way and manner family structure operates. The shift from a traditional single-income family to a double-income family where the couple play multiple roles causes conflicts due to limited time.

The construct WFC typically focuses on the difficulties employees have while balancing their work and family responsibilities. The interest in WFC studies has been fuelled by its negative consequences on employees and the organization (Thomas and Ganster, 1995). Previous works found that WFC affects employees' self-development and career advancement (Jayaweere, 2005), causes absenteeism and poor work performance, enhance low level of job satisfaction (Adams, *et al*., 1996) and causes low performance and employees' turnover (Kossek and Ozeki, 1998).

Work-Family Conflict is operationalized as the inter-role conflict in which the role pressure from the work and family domains are mutually incompatible, that is, the participation in the work (family) role is made more difficult by virtue of participation in the family (work) role. Netemeyer *et al.,* (1996) noted time-based conflicts, strain-based conflicts and behaviour-based conflicts as the three categories of WFC. Time-based conflict occur if employees cannot balance working time with family time while strain-based conflict arises when stress arising from work negatively affects family life or inability to separate work problems from personal problems. Furthermore, as captured by Netemeyer *et al.,* (1996), behavior-based conflict occurs when behaviours at work such as authoritative are applied to family life.

More significantly, Robbins and Judge (2013) accentuates that job satisfaction is often negatively related to work-family conflict. Employees who view their work as making it difficult for them to satisfy their family roles will likely be less satisfied with their job as it is seen as the source of the conflict. Herzberg's Two-Factor Theory explained that job satisfaction includes achievement, recognition, work itself, responsibility, progress, and growth (Isfianadewi and Norrdiana, 2020). On the other hand, role theory explains the relationship between WFC and job satisfaction, the theory assumes that individuals with multiple identities tend to conflict because of an imbalance between identities (Rathi and Barath, 2013). It therefore becomes important to examine the outcomes of WFC and whether time-based conflict, strain-based conflict and job satisfaction positively or negatively correlates with WFC.

Materials and Methods

The study was conducted at the Federal University of Agriculture, Abeokuta, Ogun State, Nigeria. The Federal University of Agriculture, Abeokuta (FUNAAB) was established on January 1st 1988 (www.unaab.edu.ng) with the tripodal mandate of teaching, research and extension services. A simple random sampling technique was used to select 107 employees which comprises of teaching and non-teaching staff across departments, units and centres within the university. A structured and validated questionnaire was used to elicit information from the employees. Time-based Conflict (TBC) and Strain-Based Conflict (SBC) were measured using 5-items scales adopted from Carlso *et al*., (1998) such as my work keep me away from my family activities more than I would like" while SBC was "because of family responsibility, I do not concentrate at work' the internal consistency reliability for the scale was 0.75 and 0.82 for TBA and SBC respectively. Also, supervisor support was measured on a 9-items scale using Cronbach alpha of 0.80 and Work-Family Conflict (WFC) was measured on 6-items scales adopted from Kopelman *et al.,* (1983). Cronbach alpha for the scale was 0.75. The responses on the scale items were ordered on a Likert scale of strongly agree (5), agree (4), undecided (3), disagree (2) and strongly disagree (1). Three biographical variables were included in the analysis. The biographical variables included age, sex and years of experience. Data were analyzed using Principal Component Analysis (PCA), correlation and hierarchical regression.

Results and Discussion

Results in Table 1 are the descriptive statistics, alpha reliabilities and correlation of the study variables. The internal consistency reliabilities of the scales employed for the study ranges from .750 to .89 and are considered good (Hair, *et al*., 1992). Finding shows a positive correlation between time-based conflict (r = .493*), strain-based conflict conflict (r = .429**) and WFC. This finding implies that employees who spend greater amounts of time at work are more likely to face conflicts as family time is taken away by the work role. Also, it was noted that employees whose work role interferes with their family role cannot satisfy roles in the same time. Furthermore, employees with high levels of strains at work are more likely to have conflict when family responsibilities interfere with work roles. It therefore adduced that strain-based conflict in the workplace can impact on WFC and also spill-over to affect the employees' family life.

Table 1: Inter-correlation of strain, time, job satisfaction, support supervisory and WFC

	1	2	3	4	5	6	7	8
Age	-							
Sex	-.106	-						
Work experience	.751**	.143	-					
Strain	-.066	-.072	-.220*	.820				
Time	-.020	-.075	-.130	.363**	.759			
Job satisfaction	.183	.047	.113	-.031	.071	.894		
Support supervisory	.078	-.235*	-.060	.065	.099	.391**	.808	
Work-family conflict	-.286**	.033	-.318**	.429**	.493*	.067	.154	.750
Mean	43.53	-	12.00	11.58	14.64	45.09	33.78	18.53
sd	9.220	-	8.714	4.626	4.174	8.874	5.921	4.732

$*p< .05$; $**p<.001$. Alpha reliabilities are in bold italics in diagonal. N=107

An exploratory principal component (PC) analysis was performed to test the hypothesis which states that factors that influence WFC are not significantly related. Table 2 show that 4 item loadings of ±0.70 and above were included in the factor and this accounted for 62.81% of the total variability with eigenvalue of equal to or greater than one, since one of the aim of factor analysis is the reduction of data, the significant items are, been irritable at home (0.71), tiredness at home (0.75), having much to do at work (0.75) and work interfering with family life (0.71). It was therefore noted that the PCA model transformed a 6-dimensional WFC items into 4-dimensions. It then implies that been irritable at home, tiredness at home, workloads and inter-role conflicts of work and family are the predominant outcomes of WFC experienced by employees. This corroborates Akintayo (2010) who noted that WFC is a strong predictor of work commitment and job satisfaction.

Table 2: Principal Components Analysis of (Varimax) of Work-Family Conflicts

Items	1	2
1. Because my work is demanding, at times I am irritable at home	.710	.157
2. After work, I come home too tired to do some things I had like to do	.753	-.061
3. At work, I have so much to do that it takes away from my personal interest	.757	.377
4. My work takes up time that I would like to spend with my family	.718	-.433
5. I am too often tired at work because of things I do at home	.625	.331
6. Others dislike how I am preoccupied with my personal life while at work	.432	.751
Eigen value	2.738	
Percent variation (%)	7.18	
Cumulative (%)	62.81	

Source: computed from survey data, 2021; sig≥0.70; N=107

The result of the hierarchical regression analysis in Table 3 shows that the predictors of strain-based conflict (β = .38, p< .0001) and time-based conflict (β = .29, p< .0001) have a positive relationship with WFC. The result implies that strain-based conflict and Time-based conflict have made about .81% unfair treatment on employees WFC. The study posits that time is a major aspect of conflict. Consequently, an employee whose work role interferes with their family role cannot satisfy both role in the same time. In addition, potential sources of strain-based conflict such as emotional demands in workplace could affect WFC.

Table 3: Result of hierarchical regression analysis of predictors on WFC

Variables	beta	t-ratio	sig
Strain-based conflict	.38	4.37	.00
Time-based conflict	.29	3.58	.001
Job satisfaction	.94	0.60	.54
R-square	.81%		
F	23.74		
Sig F	.00		
Durbin Watson	1.766		

*p< .0001; N=107

Conclusions and Recommendations

The study concluded that tiredness at home, workloads and inter-role conflicts of work and family are the predominant outcomes of WFC and there was a positive correlation between time-based conflict, strain-based conflict and WFC. Employees spending greater amounts of time at work are more likely to face conflicts as family time is taken away by the work role. It is therefore recommended that social support be provided to employees in order to manage time and strain related conflicts, also, practices such as domestic leave, annual leave, study leave and flexible work should be effectively implemented to make family life easier and therefore make work easier and managing WFC.

References

Adams, G. A., King, L. A., & King, D.W. (1996). Relationships of job and familyinvolvement, family social support, and work-family conflict with job and lifesatisfaction, *Journal of Applied Psychology*, 81(4), 411-420. doi:10.1037/0021-9010.81.4.411

Akintayo, D. I. (2010). Work-familyrole conflict and organizationalcommitment among industrial workers in Nigeria. *InternationalJournal of Psychology and Counselling*,2(1), 1-8. Retrieved fromhttps://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.853.3656&rep=rep1&type=pdf

Carlson, D.S. Kacmar, K.M. & L.J. Williams, (1998).The development and validation a multidimensional measure of work family conflict. *Academy of Management*, San Diego.

Hair, J. J., Anderson, R.E ; Tatham, R. L., & Black, W.C. (1998) *Multivariate data analysis*. New Jersey: Prentice-Hall International, Inc.

Jayaweera. A. T. (2005). Management development: A model of linkages between work family conflict, job satisfaction and individual's passionate desire to develop through management development opportunities, *SAARC Journal ofHuman Resource Development*, 108-116.

Kossek, E. E. & Ozeki, C. (1998). Work-family conflict, policies, and the job-life satisfaction relationship: A review and directions for organizational behavior-human resources research. *Journal of Applied Psychology*, 83(2), Pp.139-149.

Kopelman, R. E., Greenhaus, J. H., & Connolly, T. F. (1983). A Model of Work,Family, and Inter-Role Conflict: A Construct Validation Study, *OrganizationalBehavior and Human Performance*, 32(2), 198-215. doi:10.1016/0030-5073(83)90147-2

Netemeyer, R. G., Boles, J. S., & McMurrian, R. (1996). Development and validationof work-family and family–work conflict scales, *Journal of AppliedPsychology*, 81(4), 400-410. doi:10.1037/0021-010.81.4.400

Isfianadewi, D., & Noordyani, A.(2020). Implementation of CopingStrategy in Work-Family Conflicton Job Stress and Job Satisfaction:Social Support as ModerationVariable. *Review of IntegrativeBusiness and Economics Research*,9(2), 223-239. Retrievedfrom http://buscompress.com/uploads/3/4/9/8/34980536/riber_9-s2_38_k19-104_223-239.pdf

Rathi, N., & Barath, M. (2013).Work-family conflict and job andfamily satisfaction: Moderatingeffect of social support among policepersonnel. Equality, Diversityand Inclusion: *An InternationalJournal*, 32(4), 438-454. https://doi.org/10.1108/EDI-10-2012-0092

Robbins, S. P., & Judge, T. A.(2013). Organizational behavior(15th ed.). Prentice-Hall. Retrievedfrom https://books.google.co.id/books?hl=id&lr=&id=-

Thomas, L. T., & Ganster, D. C. (1995). Impact of family-supportive work variables on work-family conflict and strain: A control perspective, *Journal of Applied Psychology*, 80(1), 6-15. doi: 10.1037/0021-9010.80.1.6

14 MICROBIOLOGICAL QUALITY OF OVEN ROASTED PLANTAIN (*Musa Parasidiaca*)

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Abstract

In this study, the microbiological quality of oven roasted plantain was investigated and compared with open charcoal roasted roadside sold plantain purchased from Tunga market, Minna, Niger State (Control). The Total Viable Count (TVC), Total Plate Count (TPC), Total E. coli Count (TEC) and Total Staphylococcus Count (TSC) were accessed by inoculating into different selective media using MacConkey agar, Nutrient agar and Mannitol salt agar for day 0, day 5 and day 10 after production. TVC ranged from 1.0×10^6 to 2.0×10^7 cfu/g while TPC ranged from 1.0×10^6 to 2.40×10^7 cfu/g. The TEC recorded no growth for day 0 to day 5. However, the growth became visible at day 10 in CU_{10} (3.0×10^6 cfu/g) and OP_{10} (1.5×10^6 cfu/g) while TSC ranged from no growth on day 1 to 2.1×10^7 cfu/g on day 5. The level of contamination of oven roasted plantain and charcoal roasted boli were high and above the International Commission for Microbiological Specification for Foods (ICMSF) standards for ready to eat foods. Therefore, there is need to create more awareness among the vendors as well as the consumers of the roasted product as it is exposed to various sources of contamination such as polycyclic aromatic hydrocarbons, dusts etc. to avoid any associated health implications.

Key words: Microbiological quality, Roasting, Plantain, Inoculation, Selective media.

INTRODUCTION

In Nigeria, plantain is eaten in many forms such as boiled, fried or even snacks i.e. the famous roasted, delicacy called '*boli*'. In china, plantain is processed into durable flour for subsequent usages. (Oluwalana *et al*., 2011). Matured plantains from which *boli* is made are a very rich source of nutrients such as 60% water, 32% carbohydrates, 1% proteins, 0.02% fats and some vitamins and minerals elements (Oluwalana and Oluwamukomi, 2010).

Roasted plantain or *boli* is a Nigerian native dish especially to the Yoruba people. It is referred to as either "*boli*" or "*bole*" and eaten with groundnut or fish in southern Nigeria.

The Nigerian conventional method of processing *boli* used by roadside food vendors involves open charcoal roasting which exposes the product to various sources of contamination such as polycyclic aromatic hydrocarbons (PAHs), dust, fumes and flies etc. posing a risk of food contamination to consumers especially as the local snack is gaining a high consumption rate due to the increasing urbanization in Nigerian cities such as Minna, Niger State. Most food vendors in the developing countries like Nigeria and Minna precisely are not adequately informed on good manufacturing practices and basic food sanitary measures and practices. Consequently, these street foods are most times subjected to various contamination sources at different levels of handling (Rane, 2011). Hence, it is necessary to maintain personal hygiene, as well as good manufacturing practices to ensure product safety of such foods.

There is need to process plantain in an oven and compare the microbiological quality with the open charcoal roadside sold ones.

MATERIALS AND METHODS

Source of Raw Material: Not too ripe plantain and charcoal roasted plantain (*boli*) were bought from Tunga market, Minna, Niger state.

Preparation of oven roasted plantain: The plantains were thoroughly sorted and cleaned using clean running water in order to remove foreign materials such as sand, glue and dirt etc. The plantains were thereafter weighed using an electronic weighing balance in order to ascertain their weights before and after production. Crown Star electric roaster oven (Model: MC – 1985K) was preheated at 190˚C for 15 minutes, and then roasting was done at 200˚C for 30 minutes for peeled plantain while for unpeeled plantain, roasting was carried out at 200˚C for 40 minutes.

Microbial Analysis: Microbial analysis was carried out using the method of Ojokoh (2006), which involved preparation of media, diluents, serial dilution, inoculation, incubation, subculture, gram stain. Test tubes were washed and rinsed with clean running water in order to remove contaminants and filled with 9 mL of clean water prior to sterilization. Test tubes alongside with culture media (nutrient agar, MacConkey agar and manitol salt agar) were sterilized in an YX – 280A model autoclave at 121˚C for 15 minutes in order to destroy all potential microbes. The test tubes and culture media were cooled to 45˚C to avoid the heat from destroying the nutrients and microbes present in the samples before analysis.

Inoculation was carried for 1g of each sample. Serial dilution was carried out after inoculation using a new sterile syringe. Thereafter, 1 mL of the sample was transferred into petri dishes. Beakers containing agars were sterilized using open flame. The agars were then added into the petri dishes and stirred gently. The samples were left to gel or solidify for 20 – 25 minutes and incubated for 24 hours in a Gallentant (Model: 1971s) electronic incubator at 37˚C. This process was carried out for day 0, day 5 and day 10 and the total microorganisms were counted and recorded.

RESULTS AND DISCUSSION

Table 1: Microbial analysis of roasted plantain (charcoal, oven, peeled and unpeeled).

SAMPLE	TVC (cfu/g)	TPC (cfu/g)	TEC (cfu/g)	TSC (cfu/g)
CP_0	1.0×10^6	1.0×10^6	NG	NG
CU_0	3.0×10^6	9.0×10^6	NG	NG
OP_0	1.6×10^7	2.1×10^7	NG	NG
OU_0	1.4×10^7	1.8×10^7	NG	NG
CP_5	5.0×10^6	1.9×10^7	NG	2.1×10^7
CU_5	1.7×10^7	2.7×10^7	NG	NG
OP_5	9.0×10^6	3.9×10^7	NG	NG
OU_5	6.0×10^6	1.5×10^7	NG	NG
CP_{10}	2.8×10^6	3.0×10^7	NG	8.0×10^6
CU_{10}	2.0×10^7	2.40×10^7	3.0×10^6	3.16×10^6
OP_{10}	7.0×10^6	7.1×10^6	1.5×10^6	4.3×10^6
OU_{10}	9.8×10^6	1.12×10^7	NG	9.2×10^6

KEY: TVC = Total Viable Count. TPC = Total Plate Count, TEC = Total *E.coli* Count, TSA =Total *Staphylococcus aureus* Count, CU = Charcoal Unpeeled, CP = Charcoal Peeled, OU = Oven Unpeeled, OP = Oven Peeled, NG = No Growth, 0 = Day 0, 5 = Day 5 and 10 = Day 10.

Day 0 Microbial Quality: Table 1 showed the microbial quality of oven roasted and charcoal roasted plantain (peeled and unpeeled) on day 0 of production. The total viable count for oven peeled sample recorded the highest count (1.6×10^7 cfu/g) while charcoal peeled recorded the lowest (1.0×10^6 cfu/g). The values were low compared to the ones gotten from various streets of Accra, Ghana (Maxwell *et al.*, 2000). The total plate count ranged from 1.0×10^6 to 2.1×10^7 cfu/g. The high counts of TVC and TPC indicate improper processing or cross contamination as well as post process recontamination with dirty utensils and handlers etc. as well as improper storage which result into high multiplication and spread of toxigenic and pathogenic organisms (Vedesh and Neel, 2017).

Day 5 Microbial Quality: Table 1 showed the microbial quality for oven roasted and charcoal roasted (peeled and unpeeled) on day 5 after production. For TVC, charcoal peeled count recorded the lowest (5.0×10^6 cfu/g) while charcoal unpeeled count recorded the highest (1.7×10^7 cfu/g). This high count could be as a result of the infested plantain skin with microorganisms because certain microbes such as Penicillums spp, Bacillus subtilis, etc. are associated with the supply chain of plantains (Fajinmi *et al*, 2011). The presence of Staphylococcus aureus was 2.1×10^7 cfu/g from charcoal peeled sample. The presence of Staphylococcus aureus signifies respiratory contamination from the food handler as this microorganism is introduced into street vended foods during handling and vending (Sandel and Mckillip, 2004).

Day 10 Microbial Quality: Table 1 showed the microbial quality of oven roasted and charcoal roasted (peeled and unpeeled) plantain after 10 days of production. There was no growth of *E. coli* in charcoal peeled and oven unpeeled samples. However, its growth was observed in the charcoal unpeeled and oven peeled samples. Staphylococcus aureus indicated growth for all the days. The appearance of *E. coli* in food samples indicates the use of unhygienic practices, poor water quality used in washing the raw plantains (Rasmi *et al*., 2012). This also indicated improper hygienic practices especially in the location of the food environment (Suneetha *et al*., 2011). This is in line with an experiment which was done in Lokoja streets by Madueke *et al.* (2014) and reported that the food samples harbored microorganisms such as *E. coli*, Staphylococcus aureus etc.

CONCLUSION

The microbial analysis showed the level of contamination of oven roasted and charcoal roasted plantains (*boli*) were high. It is noted that the total viable count, total plate count, total Staphylococcus count and total *E. coli* counts were more than the recommended reference level. The International Commission for Microbiological Specification for Food (ICMSF, 1996) stated that ready to eat foods between the values of 10^3 are acceptable, 10^4 to 10^5 tolerable. However, 10^6 and above are unacceptable hence the eating of the ready to eat foods such as roasted plantain (*boli*) is an avenue to increase the risk of food borne diseases. In the present study, the microbial counts of the analyzed microorganisms (TVC, TPC, TEC and TSA) all exceed the recommended levels as prescribed by the ICMSF and are harmful to our health

REFERENCES

Fajinmi, O.B., Akinyemi, S.O.S., Aduramigba, M and Odupe, A.O (2011). Influence of storage methods on ripening and microbial loads of some Musa species. Agricultural and Biology of North America, 2 (8): 1201-1207.

International Commission on Microbiological Specification for Foods (ICMSF) (1996).

Microorganisms in food; samples for microbiological analysis: principles and specific application. Recommendations of the International Commission on Microbiological Specifications for Food. Association of Microbiological Societies, University of Toronto press, ISO 1995.

Madueke, S.N. and Jonah A.L. (2014). Microbiological analysis of street food along Lokoja-Abuja express way, Lokoja. AM.J.Res. Commun., 2 :196-211.

Maxwell, D., Levin, C., Armar-klemesu, M., Ruei, M., Moris, S and Ahiadeke, C. (2002). Urban livelihood and food and nutrition security in greater Accra, Ghana. Int. Food Policy Res. Instit., 112:117-119.

Ojokoh, A.O. (2006). Microbiological examination of ice cream sold in Akure. Pak. J.Nutr., 5(6):536-538.

Oluwalana, I.B. and Oluwamukomi, M.O. (2010). Changes in qualities of ripening plantain fruit stored at tropical ambient conditions. International Journal of Agriculture and Food Science, (1):203-207.

Oluwalana, I.B., Oluwamukomi, M.O., Fagbemi, T.N. and Oluwafemi, G.I. (2011). Microbial and sensory qualities of plantain flour and its reconstituted dumpling (amala) as influenced by blanching temperature and duration. Journal of Sustainable Technology, (2):70-73.

Rane, S. (2011). Street vended food in developing world: hazard analysis. Indian J. Microbial, 51(1):100-106.

Rashmi, H., Poojara, A. and Krishnan, G. (2012). Microbiological profile of street vended foods in Cochin, Kerala, India. Biosci. Discov., 3(2):179-185.

Sandel, M.K. and Mckillip, J.L. (2004). Virulence and recovery of Staphylococcus aureus relevant to the food industry using improvements on traditional approaches. J. Food Control, 15:5-10.

Suneetha, C., Manjula, K. and Depur, B. (2011). Quality assessement of street foods in Tirumala. Asian J. Exper. Sci., 2:207-211

Vedesh, R. and Neel, A. (2017). Microbial anaiysis of street foods of different location at Chennai city, India. Idian J. Appl. Biosci., 11:33-41

15 A REVIEW OF FOOD SECURITY AND POVERTY STATUS OF WOMEN FARMERS UNDER IFAD-VCDP IN NIGER STATE, NIGERIA

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Abstract

Food insecurity remains a major developmental issue around the world, undermining people's health, productivity, and survival. This review evaluated the food security and poverty status of women farmers under IFAD-VCDP in Niger State, Nigeria. Systematic review was adopted and all the relevant documents (research articles and book chapters) were sorted according to laid-down eligibility criteria access one hundred and ten research articles and book chapters for the review. The review revealed that age, education, access to land, and annual income have significant and positive relationship with household food security. Also, majority of farmers were food insecure, women and children are the most vulnerable to poverty in developing countries such as Nigeria. The study therefore recommended that relevant stakeholders (State government, Non-governmental organization and community based organization) should intensify efforts to reduce or if possible, eliminate poverty among households in Nigeria.

Keywords: Food security; poverty; women farmers; IFAD-VCDP;

Introduction

The world's population is projected as at December 2021 to be 7.9 billion, and feeding them is a big challenge due to climate change and limited natural resources (FAO, 2020). Global hunger is severe because about 30% of people worldwide are currently malnourished resulting from insufficient calorie intake, protein deficiencies, poor food quality, and insufficient levels of protein and micronutrients (World Bank, 2014). Action against Hunger (2022) estimated that between 2019 and 2021, there was an increase in the number of undernourished individuals by 150 million. This crisis was mostly caused by conflict, climate change, and the COVID-19 pandemic. Given that, one of the most fundamental human needs is food, the issue of hunger and poverty has elevated to the top of the global agenda. The ongoing global food crisis and soaring food costs have raised concerns about food security (Chand and Gartia, 2016). Food insecurity remains a major development issue around the world, undermining people's health, productivity, and survival, despite various concerns from governments around the world about making sure that every household can at least provide three square meals for their family (FAO, 2012).

Poverty is a great enemy to human happiness. It undoubtedly undermines liberty, make some virtues impractical, and make others very challenging (Samuel, 2015). Absolute poverty is a state of life when one's existence is so constrained by illiteracy, starvation, illness, high infant mortality, and short life expectancy that it prevents one from realizing the genetic potential they were born with (Robert, 2015). According to Fontana and Paciello (2012), rural women constitute major contributors to national economy development, especially in developing nations where agricultural production is the major source of livelihood for rural dwellers. In addition, rural women play a significant role as producers of food for the maintenance of the family. Agada and Ameh (2017) reported that about 60% of the food produced comes from rural women farmers who make up about 60–80% of the agricultural labour force. Rural women in Nigeria worked side by side with men in agricultural production to enhance the livelihood of the household with a marked division of labour among them. But, rural women have lagged behind in all fields of self-advancement, coupled with the challenge of gender inequality, so their level of production has reduced. The problem of declining crop productivity in Nigeria is compounded by women's inadequate access to production resources. The Value Chain Development Programme (VCDP) is a development initiative that focused on the Value Chain Development (VCD) due to the challenges faced by smallholder farmers such as low productivity, poor market access, poor processing technology, insufficient information on recent innovation in agriculture, high farm input costs, insufficient credit systems, the vicious cycle of poverty, and the recent challenge that appears formidable; climate change (IFAD, 2013). Therefore this study reviewed all related literature on the food security and poverty status of women farmers under IFAD-VCDP and specifically reviewing all related literature on Socio-economic Factors Influencing Participation of women in farming and Food Security and Poverty Status of Women Farmers.

Methodology

Systematic review was adopted for this review. Information on the food security and poverty status of women farmers were retrieved from electronic database which include Google Scholar, Research Gate, and Semantic Scholar, using search terms of “food security and poverty status”, role of women in agriculture”, “socioeconomic characteristic of women farmers”, “food security status of women farmers” and poverty status of women farmers. A database was created for the articles, books, and conference papers published from 2000 to 2020 obtained. Based on the eligibility criteria as regards their relevance (unavailability of full text or not published in English), one hundred and ten research articles and book chapters containing relevant and useful information were included in this review. The study was carried out in two phases. The first phase describes the socio-economic characteristics of women farmers while the second phase involved studies on food security and poverty status of women farmers.

Socio-economic characteristics of women farmers

Several studies (Iram and Butt 2006; Arene and Anyaeji 2010; Sharaunga *et al*., 2016; Ebeh and Agama, 2018) argued that age has a significant and direct relationship with household food security levels. Age of women farmer, for instance, is significant in assessing the level of food security in the home because age is linked to experience. Older women may have greater grasp of the nutritional requirements of the family and the quality of food available. Titus and Detokunbo (2007) and Ahmed and Abah (2014) negate this assertion in their research on the food security situation among Nigerian urban households in Nigeria. The study revealed an inverse relationship between the age of household head and food security. To this end, as the age of the household head increases, there is likelihood of household food security to decrease. Also, Ojo *et al.* (2012) carried out a study on women's accessibility to resources needed for increased agricultural production in Borno State, Nigeria. The result showed about 85% of the respondents to be less than 50 years. This has direct influence on availability of able-bodied labour force for primary production and ease of adoption of innovations.

Education is believed to increase farmers' ability to obtain, and analyze information that help them make appropriate decision. Farmers with better education have more exposure to new ideas and information, and thus have better knowledge to effectively analyze and use available information (Kassie *et al*., 2013). Meanwhile, most studies consider education in terms of number of years spent in pursuing formal education, the categorization of education by Baumgart-Getz *et al*. (2012) seems more appropriate: in contrast to formal education, it reflects knowledge farmers attain through other means such as extension programmes, workshops, and field days. Similarly, Yengoh (2012) found education to enhance productivity and efficiency among farming households in the humid forest, dry savannah, and moist savannah agro-ecological zones of Nigeria. Marital status: this entails the status of being married or not. Marital status determines access, control and ownership of agricultural productive resources (Rahman and Usman, 2004). The study, therefore, expects variations in access, control and ownership of agricultural resources because of differences in marital status. Gashaw (2015) reported married women to be more involved in income generating activities in Ambo Town. Household heads dominate decision making regarding the choice of technologies and farm inputs utilization. Similarly, as the household size increases, there is the likelihood that the farm size will increase (Meybeck *et al.*, 2018).

Food Security and Poverty Status of Women Farmers

In a qualitative study on the determinants of household food security in Nigeria, Arene and Anyaeji (2010) found about 60% of the households to be food insecure. More so, income, household head and age were the most significant factors determining food security. Similarly, the determinant of food security among rural women in Kaduna State, Nigeria was examined by Olagunju *et al.* (2020). The study revealed that rural women in Kaduna State have reasonable access to food. These negate the findings of Adereti and Fasina (2017) who found that about 45.8% of the rural women in Ondo State were food insecure with severe hunger. More so, the factors influencing household food security in Nigeria was examined by Haile *et al.* (2015). The study revealed that household size is the key determinant of food security. The study added that food insecurity increases with the increase in the number of family members and vice versa. Study conducted by Guo (2013) on household assets and food Security showed that household assets have a significant association with food security. According to Owusu *et al.* (2011), non-farm activities affect household food security in Ghana.

The rising poverty among the rural populace in developing countries has retarded economic development in these areas (UNIDO, 2010; Busari *et al.*, 2021). The most vulnerable groups in these regions are women and children (Busari *et al.*, 2021). Women are often the most vulnerable since it is their responsibility to ensure children's and family welfare (Awotide *et al.*, 2010). According to NBS (2012), about 68% of the extremely poor are dependent on agriculture and live in rural areas. Busari *et al.* (2021) examined the poverty status of women in rural farming households in Iwo Local Government, Osun State, Nigeria. The study revealed that there is high level of poverty among the rural women. Therefore emphasize the need to enhance the economic situation of the rural women through rural development policies that will empower them to have access to qualitative education, participate in credit associations, diversify their sources of income, and build their capacity through skill training. Similarly, the study of Mukaila *et al.* (2012) reported that poverty is pervasive among rural women in Nigeria. The study added that the positive driving factors which contributed to high poverty among the rural women were age, household size, and practicing of mono-cropping system.

Conclusion and Recommendations

The study reviewed the food security and poverty status of women farmers under IFAD-VCDP. From the review of related literature, it can be concluded that majority of rural women farmers were food insecure and women and children are the most vulnerable to poverty in Nigeria. Also, age, education, access to land, and annual income have a significant and direct relationship with household food security. In addition, a few studies were carried out as regards the poverty status of rural women. The study therefore recommended that relevant stakeholders (State government, Non-governmental organization and community based organization) should intensify efforts to reduce or if possible, eliminate poverty among households in Nigeria.

References

Action against Hunger (2022). Key facts about Global hunger today. Retrieved from https://www.actionagainsthunger.org/world-hunger-facts-statistics

Adereti, D. T. & Fasina, O. O. (2017). Gender analysis of food security status of rural households in Ondo State, Nigeria. *Russian Agricultural Sciences, 43(4), 353–360.*

Agada, M. O. & Ameh, E. (2017). Rural women's involvement in agriculture in Okpo District, Kogi State, Nigeria. *Global Journal of Science Frontier Research, Agriculture and Veterinary* 17 (4), 2-3.

Ahmed, F. F. & Abah, P. P. (2014). Determinants of food security among low-income households in Maiduguri Metropolis of Borno State, Nigeria. *Asian Journal of Social Sciences and Humanities,* 3(1): 4-86.

Arene, C. J. & Anyaeji, R.C. (2010). Determinants of food security among households in Nsukka Metropolis of Enugu State, Nigeria. *Pakistan Journal of Social Sciences*, 30(1): 9-16.

Awotide, B. Diagne, A. Awoyemi, T. & Ojehomon, V. (2015). Farm-level constraints and adoption of improved rice varieties in Nigeria. *Journal of Agriculture and Envi-ronmental Studies,* 1(2): 12-29

Baumgart-Gertz, A., Prokopy, L. S. & Floress, K. (2012). Why farmers adopt best management practices in the United States: A meta-analysis of the adoption literature, *Journal of Environmental Management*, 96(1), 17 – 25

Busari, A. O., Idris-Adeniyi, K. M., & Alabi, A. A. (2021). Poverty status of women in rural farming households in Iwo Local Government, Osun State, Nigeria. *Journal of Science in Agriculture*,12(7), 67 – 74

Chand, A. & Gartia, M. B (2016). The Chain of effects from brand trust and brand affects to brand performance: the role of brand loyalty, *Journal of marketing*, 55(3), 661-668

Ebeh, J. E. & Agama. S. A. (2018). Determinants of food security among households in Dekina Local Government area of Kogi State, Nigeria. *Lafia Journal of Economics and Management Sciences*, 3(2): 43-43.

FAO, (2012). Assessment of the world food security situation: committee on world food security, 23–26 may, 2005. FAO, Rome Italy.

FAO, (2020).The state of food insecurity in the World, Food and Agriculture Organization of the United Nations. Rome.

Fontana, M. & Paciello, C. (2010).Gender dimensions of rural and agricultural employment: differential pathways out of poverty: *a global perspective. in gender dimensions of agricultural and rural employment: differentiated pathways out of poverty. FAO/IFAD/ILO, Rome.*

Gashaw, A. (2015). Assessment of the roles and constraints of women in economic development of Ethiopia: The Case of Ambo Town since 1991", *Journal of Political Sciences and Public Affairs*.3(1), 26-32 DOI:10.4172/2332-0761.1000148.

Guo, B. (2013). Evaluation of Ethiopia's Food Security Program: Documenting Progress in the Implementation of the Productive Safety Nets Programme and the Household Asset Building Programme". Ethiopia Strategy Support Program II (ESSP II). International Food Policy ResearchInstitute. Institute of Development Studies, University of Sussesex.

Haile, H. K., Alemu, G. & Kudhlande, G. (2015).Causes of household food insecurity in Koredegaga peasantassociation, Oromiya zone, Ethiopia,Working paper, Department of Agricultural Economics, Faculty ofAgricultural Sciences, University of the Free States.

Iram, U. & Butt, M.S. (2006). Understanding the health and nutritional status of children in Pakistan: A study of the interaction of socioeconomic and environmental factors. *International Journal of Social Economics, 33: 111-131.*

Kassie, M., Jaleta, M., Shiferaw, B., Mmbando, F. & Mekuria, M. (2013). Adoption of interrelated sustainable agricultural practices in smallholder systems: Evidence from rural Tanzania. *Technological Forecasting and Social Change,* 80(3), 525-540

Meybeck, A., Laval, E., Lévesque, R., & Parent. G. (2018). Food Security and Nutrition in the Age of Climate Change. *Proceedings of the International Symposium organized by the Government of Québec in collaboration with FAO. Québec City, September 24-27, 2017. Rome, FAO. pp. 132. Licence : CC BY-NC-SA 3.0 IGO.*

Mukaila, R., Falola, A., Akanbi, S.-U. O., Aboaba, K. O., & Obetta, A. E. (2022). Drivers of poverty among rural women in Nigeria: Implications for poverty alleviation and rural development. *The Journal of Rural and Community Development*, *17*(1), 32–48.

National Bureau of Statistic (NBS), (2012). Quarterly report. Retrieved from https://www.nigerianstat.gov.ng/

Ojo, M. A., Usman, M. A., Mohammed, U. S., Ojo, A. O. & Oseghale A. I. (2012). Effect of insurgency on food crop farmers' productivity in Borno and Gombe States, Nigeria. *Journal of Agriculture,* 30 (3), 43 – 55.

Olagunju, O. E., Ariyo1, O. C., Emeghara, U. U., & Olagunju, O. S. (2020). Determinants of food security among rural women in Kaduna State, Nigeria *Asian Journal of Agricultural Extension, Economics and Sociology, 38(10),* 70-82

Owusu, S. (2017)Effect of access to credit on agricultural productivity: evidence from cassava farmers inthe Afgya-Kwabre District of Ghana. *International Journal of Innovative Research in Social Sciences and StrategicManagement Techniques,* 4(2): 55–67.

Rahman, S. A. & Usman, J. I. (2004).Comparative analysis of women participation in agricultural production in northern and southern Kaduna State, Nigeria. *Proceedings of the 38th annual conference of the Agricultural Society of Nigeria, held at college of agriculture, Lafia, Nasarawa State, Nigeria,* Oct. 17th – 21st Pp.103 – 113.

Samuel, A. (2015). Adoption of organic farming technologies in banana and vegetable crops in

Kasaragod District. *Journal of Science in Agriculture*,5(*20*), 67 – 74

Sharaunga, S., Mudhara, M. & Bogale, A. (2016). Effects of women empowerment on household food security in rural KwaZulu-Natal province. *Development Policy Review*, 34(2): 223-252.

Titus, B. & Adetokunbo, G. (2007). An analysis of food security situation among Nigerian urban households: Evidence from Lagos State, Nigeria. *Journal of Central European Agriculture*, 8(3): 397-406.

United Nations Industrial Development Organization (UNIDO) Annual Report (2010)

World Bank, (2014).World Development Report 2013/2014. Attacking poverty, New York, N.Y.,OxfordUniversityPress(www.worldbank.org/poverty/wdrpoverty/report/)

Yengoh, T. G. (2012). Determinants of yield differences in small-scale food crop farming system in Cameroon. *Journal of Agriculture and Food Security*, 1(1), 21-27

16 COMPARATIVE ANALYSIS OF THE EFFECT OF ANCHOR BORROWERS PROGRAMME (ABP) ON FOOD SECURITY STATUS OF RICE FARMERS IN EBONYI AND KEBBI STATES, NIGERIA

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ABSTRACT
The study compared the effect of Anchor Borrowers'Programme (ABP) on food security status among beneficiary rice farmers in Ebonyi and Kebbi States, Nigeria. A multi-stage sampling procedure was used to select a total of 439 beneficiaries. This comprises of 218 respondents from Ebonyi and 221 from Kebbi States respectively. Primary data were collected through structured questionnaire administered to the sampled respondents by trained enumerators. The data were analyzed with the use descriptive statistics, food security index and Probit regression model. Results showed that the mean ages of the farmers were 49 and 46 years old, 69.27% and 92.31% of them were males, 92.20% and 93.21% were married, with an average farming experiences of 18 and 20 years and average household size of 9 and 14 persons, in Ebonyi and Kebbi States, respectively. Following the same sequence they had monthly income of ₦43,666.26 and ₦38,013.87 while 68.78% and 70.18% were food secured respectively. Similarly, ABP significantly influenced food security status of the respondents at $p \leq 0.01$ for both states. It was concluded that the farmers were moderately productive and food secured in the study area, while ABP performed relatively well in both Ebonyi and Kebbi States and thus has positive effect on the food security status of the beneficiaries. Based on findings, it is recommended that the government should consolidate on this performance by increasing funding for the programme and inclusion of more farmers into the programme in order to boost rice production.
Keywords: Anchor Borrowers Programme, Food Security, Rice Farmers, Ebonyi, Kebbi.

Introduction

Rice is a staple food that provides more than one fifth of the calorie consumed worldwide by human species, though relatively lower in protein compared to other cereals, it contains a better balance of amino acids (Oyewole and Ebukiba, 2018). Nigeria is one of the leading consumer and largest producer of rice in Africa as well as largest rice importer in the world (National Bureau of Statistics (NBS), 2017).

Over decades, Nigeria has been grappling with food insecurity and its attendant consequences leading to hunger, massive importation, and social disorders among others (Osanyinlusi and Adenegan, 2016). The poor performance of the Nigerian rice sub-sector is characterized by low level of improved farm inputs usage, high cost of inputs, diversion of subsidized farm inputs, soil degradation, annual bush burning which destroys the soil organic matter, land issues, neglect of the agricultural sector, inadequate extension agents, market failures, insufficient technical know-how in the area, poor fertilizer application and inadequate essential inputs among the small scale rice farmers in the country (Ahmed *et al.*, 2017).

Few empirical studies have been carried out to appraise the Central Bank of Nigeria (CBN) programmes and schemes geared towards agricultural development in Nigeria. For instance, Ayeomoni and Aladejana (2016) studied agricultural credit and economic growth nexus in Nigeria; Obasi (2015) looked at the efficiency of agricultural lending Scheme Fund (ACGSF) on production efficiency of rural farmers in Benue State .Obilor (2013) studied the impact of commercial banks' credit on agriculture production in Nigeria. Babatunde 2019 study effect of Fadama programme on household food security in the North central region of Nigeria. In spite these endowments Agricultural sector has continued to record a decline in food security. The findings from these studies showed that agricultural developmental programmes in form of credit to the farmers performed sub-optimally on production in the study areas. It is against backdrops, therefore, that this research aimed at comparative assessment of effect of Anchor Borrower programme (ABP) food security status of rice farmers and kebbi states Nigeria and set at addressing the following specific objectives; describe the socioeconomic characteristics of ABP beneficiary rice farmers, determine the food security status of ABP beneficiary rice farmers and examine the factors influencing the food security of rice farmers in the study areas.

Methodology

The study was carried out in Ebonyi and Kebbi States, Nigeria. Ebonyi State is located in southeastern region lies between Latitude 6^o 15' N and 11^o 30' North of the equator and Longitude 8^o 05'E and 7^o 20' East of the Greenwich Meridian. It has a total land mass of 5,533km$^{2..}$

Kebbi State is located in North-West geopolitical zone of Nigeria. The State lies between Latitude 10^0 8′ and 13^o 15′North of the equator and Longitude 3^o 30′ and $6^{o\ 02}$′ East of the Greenwich Meridian. The State has a population of about. It covers an area of 36,800sqkm^2. The land of both States allows for rice production and other agronomic activities.

Sampling Procedure and Sample Size

Multi-stage sampling procedure was used in the determination of sample size for the study. In the first stage, Ebonyi and Kebbi States were purposively selected as ABP participating States in Nigeria, due to high ABP beneficiary rice farmers. The Second stage involved purposive selection of two Local Government Areas (LGAs) with highest concentration of ABP rice farmers from each of the States while the third stage involved random selection of three villages from each of the selected LGAs to get a total of 12 villages. Taro Yamane formula was used to obtain 221 and 218 ABP beneficiary rice farmers giving a total of 439 sample size for the study (Yamane, 1973). The formula is presented in equation (1) as:

$$n = \frac{N}{1+N(e)^2} \qquad (1)$$

Where:

n = Sample size,

N=Finite population

e = Limit of tolerable error, 0.5%

1= Unit/Constant

Primary data on socio-economic profile of respondents, their food security status and factors influencing food security status of the rice farmers were collected with the aid of structured questionnaire. Analytical tools such as descriptive statistics was used to achieve objective 1, food security index was used achieve11 while Probit regression model was employed to determine objective 111. The food security index formula as used by Omonona *et al*. (2007) as expressed in equation (2):

$$Fi = \frac{\text{per capita food expenditure for ith household}}{\frac{2}{3}\text{mean per capita food expenditure of all households}} \qquad (2)$$

Where;
F_i= food security index
Thus, $F_i \geq 1$ implied food secured household (those whose per capita food monthly expenditure fall above or is equal to two-third of the mean per capita food expenditure) while $F_i<1$ implied food unsecured household (Those whose per capita food expenditure falls below two-third of the mean monthly per capita food expenditure).In order to explained the factors that influenced food security status of farmers data were further subjected to probit regression model. The Probit regression model is empirically and explicitly specified as in equation (3):

$$Y=\alpha+\beta_0+ \beta_1 ABPCRE+\beta_2 OFI+ \beta_3 FSZ+ \beta_4 FIC+\beta_5 AGE+\beta_6 HHS+\beta_7 SEX+\beta_8 EXT+\beta_9 EXP+ \beta_{10} EDU+ \beta_{11} MC+ \beta_{12} MS+ e \qquad (3)$$

Y= Food security status (food secure=1, otherwise= 0)
ABPCRE= ABP credit accessed (Naira)
OFI= Off-farm income (Naira)
FSZ= Farm size (ha)
FIC= Farm income (Naira)
AGE= Age (years)
HHS= Households size (number)
SEX= Sex (male=1, female=0)
EXT= Extension visits (number)
EXP= Farming experience (years)
EDU=Education (years)
MC= Membership of cooperative association (Member=1, otherwise=0)
MS= Marital status (Married=1, otherwise=0)
β_0= Coefficient of intercept
β_1– β_{12} = Coefficients of the explanatory variables
e = Error term

Results and Discussion

The result on socio-economic characteristics of the farmers in the study area as presented in Table 1, showed that the mean ages of farmers were 49 and 46 years in the Ebonyi and Kebbi Sates, respectively. Although, the results revealed that ABP farmers in Ebonyi were slightly older than their counterpart in Kebb Statei, but they were still in their active and productive age, strong and agile which could serve as impetus for accessing additional funds that will enhance their production. This confirms the report of Ayinde *et al.* (2017) who revealed that majority of rice farmers that benefited from Federal Government intervention in Kwara State, Nigeria, were in their productive age.

The result further revealed that majority 92.20% and 93.21% of the farmers in Kebbi and Ebonyi States were married respectively while the pooled results revealed that majority (92.71%) of the farmers were married. This was an results indication that larger proportion of the farmers from both States were married. It is believed that married individuals usually have more responsibilities than unmarried which could make them seek for additional fund that will boosts their rice production and also enhance their livelihood. This that corroborates that that of Nwalieji (2016) who reported that larger percentage of Nigeria farmers were married. In Ebonyi State attained higher educational level than that of Kebbi State. The pooled results revealed that 89.52% rice farmers had formal education, which implied that most of the beneficiary rice farmers were knowledgeable which made the adoption of ABP easier. Adoption of innovation could enhance their livelihood and income levels. These finding agrees with the report of Ayinde *et al*. (2017) who reported that access to formal education had the tendency of improving the livelihood of rural farmers in Kwara State.

Food Security Status of the Respondents

The result of food security status of the ABP beneficiary rice farmers in the study areas as presented in Table 3 revealed that 68.78% and 70.18% of the famers in Kebbi and Ebonyi States, respectively were food secure. The pooled results revealed that 69.48% of the respondent were food secure. This implied that middling proportion of the respondents in the study were food secure, this might be due to availability and accessibility of ABP fund. This finding agrees with Owolabi *et al*. (2016) who stated that majority of crop farmers in Kaduna Sate, Nigeria were food secured.

Determinants of Food Security Status of Respondents ABP beneficiary rice farmers in the Study Area

The result of Probit regression estimates on determinants of the food security status of the rice farmers was presented in Table 4.In Kebbi State, the result revealed that the coefficient of ABP credit received was positive and significant at $P \leq 0.01$ probability level. The implication of this is that an increased access to ABP credit by the rice farmers increased their likelihood of being food secured in the area. This further implied that ABP in Kebbi State had significant positive effect on the food security status of the rice farmers. The result further reveals that farm income at $P \leq 0.01$, farm size at $P \leq 0.10$, access to extension services at $P \leq 0.10$ and membership of cooperative at $P \leq 0.10$ probability levels respectively were positively significant in increasing the likelihood of being food secured among the respondents in the study area. However, household size was found to have a significant negative relationship at $P \leq 0.01$ probability level with food security among the respondents in Kebbi State.

Similarly, the result of the amount of ABP credit received had significant positive relationship at $P \leq 0.01$ probability level with food security among the ABP beneficiary rice farmers in Ebonyi State. This also implies that ABP in Ebonyi State is a huge success as it had significant positive effect on the food security status of the respondents. A further look at the result for Ebonyi showed that farm income at $P \leq 0.01$, off-farm income at $P \leq 0.01$ and education at $P \leq 0.01$probability levels were positively significant. This implies that an increase in these variables could increases the likelihood of being food secured among the respondents in the study area. Meanwhile, the coefficient of household size was negatively significant at $P \leq 0.01$probability level which implies that larger households are more likely to be food insecure.

The pooled result equally showed that the amount of ABP credit obtained by the farmers was positively significant at $P \leq 0.01$ probability level, an indication that ABP in the study area had significant positive effect on the food security status of the respondents. The income earned from off-farm activities by the farmers at $P \leq 0.01$ and their education at $P \leq 0.01$ probability levels respectively were positively significant. The implication is that as the values of these variables increase, the probability of food security increases accordingly. Conversely, the coefficient of household size at P< 0.01 probability level was negatively significant. This implies that as household sizes increases, the probability of food security decreases.

CONCLUSION AND RECOMMENDATIONS

From the findings of this study, it was concluded that the farmers were moderately food secured in the study area. The ABP performed relatively well in both Ebonyi and Kebbi States. It had significant and positive effects on the food security status of the beneficiaries in the study areas. Based on the findings from this study, the following recommendations were made:

i. The Federal Government should consolidate on the performance of the Anchor Borrowers' Programme by increasing funding for the programme and ensure more rice farmers benefit from it given that the programme has enhanced the food security status of the beneficiaries in the study areas.

ii. The Bank of Agriculture (BOA) and other financial institutions should also ensure timely and adequate disbursement of the loan to beneficiaries for timely purchase of the required production inputs. When this is done, more gains will be recorded in terms of ABP performance.

Table 1: Distribution of respondents according to socioeconomic characteristics

Variables	Frequency distribution		
	Ebonyi State(n=218)	Kebbi State(n=221)	Pooled(n=439)
Age (years)			
21 – 30		7 (3.17)	7 (1.59)
31 – 40	32 (14.72)	52 (23.53)	84 (19.13)
41 – 50	112 (51.38)	116 (52.49)	228 (51.94)
51 – 60	49 (22.48)	32 (14.48)	81 (18.45)
>60	25 (11.04)	14 (6.34)	39 (8.88)
Mean	48.73	45.73	47.18
Gender			
Male	151 (69.27)	204 (92.31)	355 (80.87)
Female	67 (30.73)	17 (7.69)	84 (19.13)
Marital status			
Single	11 (5.05)	4 (1.81)	15 (3.42)
Married	201 (92.20)	206 (93.21)	407 (92.71)
Widow	1 (0.46)	-	1 (0.23)
Divorced	5 (2.29)	11 (4.98)	16 (3.64)
Level of education			
FSLC	72 (33.03)	83 (37.56)	155 (35.31)
HND	12 (5.50)	3 (1.36)	15 (3.42)
JSCE	11 (5.05)	20 (9.05)	31 (7.06)
NCE	76 (34.86)	18 (8.14)	94 (21.41)
OND	7 (3.21)	11 (4.98)	18 (4.10)
Qura'anic	-	46 (20.81)	46 (10.48)
SSCE	20 (9.17)	31 (14.03)	51 (11.62)
University Degree	20 (9.17)	9 (4.07)	29 (6.61)
Occupation			
Agro-processing	15 (6.88)	21 (9.50)	36 (8.20)

Artisan	7 (3.21)	5 (2.26)	12 (2.73)
Civil servant	29 (13.30)	11 (4.98)	40 (9.11)
Farming	150 (68.81)	161 (72.85)	311 (70.84)
Fisheries production	9 (4.13)	15 (6.79)	24 (5.47)
Livestock production	4 (1.83)	7 (3.17)	11 (2.51)
Trading	4 (1.83)	1 (0.45)	5 (1.14)
Farming experience (years)			
1 – 10	5 (2.29)	22 (9.95)	27 (6.15)
11 – 20	155 (71.10)	137 (61.99)	292 (66.51)
21 – 30	44 (20.18)	59 (26.70)	103 (23.46)
>30	14 (6.42)	3 (1.36)	17 (3.87)
Mean	18	20	19

Source: Field Survey, 2019

Table 2: Frequency distribution of rice farmers according to food security status

Variables	Ebonyi State(n=218)	Kebbi State(n=221)	Pooled(n=439)
Food secure	153 (70.18)	152 (68.78)	305 (69.48)
Food insecure	65 (29.82)	69 (31.22)	134 (30.52)

Source: Field Survey, 2019

Table 3: Probit regression estimates on effect of ABP on food security status of respondents

Variable	Kebbi State		Ebonyi State		Pooled result	
	Coeff.	z-value	Coeff.	z-value	Coeff.	z-value
ABP credit	0.0002	3.45***	0.0003	3.31***	0.0002	5.39***
Farm income	4.99e-06	3.88***	1.83e-06	3.02***	7.34e-08	0.95
Off-farm income	2.94e-07	0.68	4.99e-06	5.16***	1.20e-06	4.04***
Farm size	0.4384	1.69*	-0.3075	-1.09	-0.0435	-0.37
Age	0.0094	0.38	0.0234	0.86	0.0180	1.31
Household size	-0.2442	-6.18***	-0.2042	-3.02***	-0.1781	-7.61***
Gender	-0.0369	-0.06	-0.2075	-0.31	0.0400	0.12
Extension contact	0.6893	1.66*	-0.2840	-0.55	0.3819	1.57
Farm experience	-0.0391	-1.18	-0.0102	-0.27	-0.0186	-1.05
Education	-0.0342	-0.87	0.2641	3.90***	0.0520	2.14**
Cooperative membership	0.7885	1.88*	0.2216	0.49	0.1250	0.62
Marital status	0.4407	0.56	-0.0590	-0.07	0.0609	0.17
Constant	0.6993	0.47	-10.3700	-2.96***	-0.6584	-0.74
Diagnostic statistics						
Log likelihood	-40.0105		-25.5472		-99.8252	
LR Chi-square	159.66***		144.72***		249.71***	

Source: Field Survey, 2019

***, ** and * implies p≤0.01, p≤0.05 and p≤0.10 probability levels of significance respectively.

REFERENCES

Ahmed, A., Xu, S., Yu, W. & Wang, Y.(2017). Comparative study on factors influencing rice yieldin Niger State of Nigeria and Hainan of China. *International Journal of Agricultural and Food Research*, 6 (1), 15 – 25.

Ayeomoni, I. O. & Aladejana, S. A. (2016). Agricultural credit and economic growth nexus: Evidence from Nigeria. *International Journal of Academic Research in Accounting, Finance and Management Sciences*, 6(2): 146 – 158.

Ayinde, O.E., Fatigun, K., Ogunbiyi, K., Ayinde, K. & Ambali, Y.O. (2017). Rice production in Kwara State: A Case-study of Anchor Borrower's Program, Kwara State, Nigeria .Available online at *https://ideas.repec.org*.

Omonona, B. T., & Agoi, G.A. (2017). An Analysis of food security situation among Nigeria urban households: Evidence from Lagos State, Nigeria. *Journal of Central European Agriculture*, 8(3), 397-406.

National Bureau of Statistics (NBS) (2017).Gross Domestic Product Economic Statistics. Retrieved on January 28, 2019 from *www.nigeriastat.gov.ng*.

Nwalieji, H. U. (2016). Comparative profit analysis of rice production enterprise among Farmers in Anambra and Ebonyi States, Nigeria. *Asian Journal of Agricultural Extension, Economics and Sociology*, 8(3), 1 – 11.

Obasi, P.C. (2015). Efficiency of agricultural lending schemes in Nigeria. *European Centre for Research Training and Development UK*, 3(2): 8 – 20.

Obilor, S.I. (2013). The impact of commercial banks' credit to agriculture on agricultural development in Nigeria: An econometric analysis. *International Journal of Business, Humanities and Technology*, 3(1): 85 – 94.

Osanyinlusi, O.I. &Adenegan, K.O. (2016). The determinants of rice farmers' productivity in Ekiti State, Nigeria. *Greener Journal of Agricultural Sciences*, 6(2): 49 – 58.

Owolabi, J. O., Oladimeji, Y. U., Ojeleye, O. A. & Omokore, D. F. (2016). Effects of farmers-pastoralists conflicts on food security in two Local Government Areas of Kaduna State, Nigeria. *Nigerian Journal of Rural Sociology*, 16 (4), 1 – 6.

Oyewole, S. O. & Ebukiba, E.S. (2018). Analysis of technical efficiency and its determinants among small-scale rice farmers in Lafia Local Government Area of Nasarawa State, Nigeria. *Agriculture and Biology Journal of North America*, 3 (6), 32 – 39.

Yamane, T. (1973). *Statistics: An Introductory analysis*. 3rd Edition, Harper and Row, New York .Accessed online at *https://www.scirp.org/(S(IZ5m*.

17 EFFECTS OF LAND DEGRADATION ON CEREAL CROP PRODUCTION IN RURAL AREAS OF NIGER STATE, NIGERIA

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ABSTRACT

The study examined effects of land degradation on cereal crop production in rural areas of Niger State, Nigeria. Three stage sampling techniques were employed to select 227 respondents for the study on which primary data were elicited from the respondent with the aid of a semi-structured questionnaire complemented with interview schedule. Data were analyzed using descriptive statistics (such as frequency, percentage, mean and Likert type rating scale). The results obtained showed that that majority (84.1%) of cereal crop farmers in the study areas had experienced one form of soil degradation or the other. Runoff (89.8%), waterlogging (78.9%) and soil structure destruction (75.3%) were the physical land degradation experienced by cereal crop farmers while low nutrient availability (96.5%) and increased soil acidity (72.1%) were the major chemical land degradation experienced by cereal crop farmers in the study area. Furthermore, soil nutrients loss ($\bar{X}$=4.5), occurrence of soil erosion and reduction of crop yield ($\bar{X}$=4.3) were the topmost effects of land degradation on the output of cereal crop farmers while terracing (87.2%), mixed farming (68.7%), organic manure (63.9%), inorganic fertilizer application and afforestation (55.5%) were the major adaptive strategies adopted by cereal crop farmers in the study area. The study recommended that that cereal crop farmers should be sensitized by relevant stakeholders (Governmental and Non-Governmental Organization) on the effects of their activities on the land which deplete soil nutrients and train on the best coping strategies for natural occurrences like flood.

Key words: land degradation, cereal production, rural area, adaptive strategies

Introduction

Land degradation is a global phenomenon that alters the production function and sustainability of agriculture and induced farmers to convert farmland into lower-value uses. The main effect of land degradation is reduction in the productivity of agricultural output. Land degradation is a menace to the future generation and entire human existence. Onyerika (2016) posited that land degradation is a major aspect of environmental degradation, its various forms include; soil erosion, land pollution, flooding, bush burning, improper waste disposal, compaction and hard setting of soil. The resultant consequences of land degradation are; washing away of soil nutrients/particles, exposures of sub soil surfaces, exposure of roots of plants/trees and foundation of buildings, poor vegetative growth and low levels of crop yield as well as total crop failure. Increase cultivation resulting in the opening up of new lands exposes the top soil to the elements of degradation and alters the natural ecological conservatory balances in the landscape (Senjobi and Ogunkunle, 2010).Land degradation, which results to a decline in land quality caused by human activities, will remain high if not checked. In the developing countries like Nigeria where a large percentage of human population depends almost totally on land resources for their sustenance, there is increasing demand for land utilization suchas grazing, fish pond construction, quarrying, crop farming amongst others (Akinnagbe and Umukoro, 2011). The drive towards safeguarding food security should be channeled towards developing agricultural practices and system that will be environmental responsive and also focus on productivity on the long term rather than immediate production and ensuing returns (Bankole *et al.*, 2012).

Growing food crops such as cereals to keep pace with population demand while retaining the quality of land and the ecological balance of the production system is a current challenge to agricultural research and policy in Nigeria. Increase in world population and other non-agricultural land use are putting extra pressure on land hence there is increasingly less land for food production due to degradation as demand for food and other agricultural products keeps increasing. Increasing food production to keep pace with growing population require more land which is not available due to degraded arable land area (Onyerika., 2016). In recent years, several modern approaches to control land degradation (soil erosion) for enhanced agricultural production and development have failed due to lack of knowledge and perception of farmers who are into various agricultural production. Farming is the main occupation of the people in the study area, thus issues related to land degradation cannot be over emphasized. These farmers have little or no information on the extent to which land degradation can affect their productivity and output level which constitutes a gap in knowledge hence the need to carry out this study on the assessment of the perceived effects of land degradation on cereal crop production in rural areas of Niger State, Nigeria. In view of the above, the study attempt to identify the forms of land degradation cases experienced by the respondents; assess the perceived effects of land degradation on cereal crop production output and examine the adaptation strategies to mitigate the effects of land degradation

METHOLOGY

The study was carried out in Niger State which is located within Latitude 10°00′N and Longitude 6°00′E with annual rainfall varying from 1300mm in the North to 1600mm in the south. The State covers a total land area of 76,363 square km with a population of 3,950,249 according to 2006

Population Census.

Three stage sampling techniques were employed to select 227 respondents for the study. The first stage involved the random selection of Bida, Shiroro and Wushishi Local Government Area from each of the three agricultural zones of Niger State. Second stage involved the selection of three villages each from the selected LGAs which are; efu ndatwaki, efu madami, edzwayagi, gwada, kafa, kuta, lokogoma, wushishi, bankogi. Primary data were elicited from respondent with the aid of a semi-structured questionnaire complemented with interview schedule. Data collected were analyzed using descriptive statistics (mean, frequency distribution count, percentages and Likert type rating scale).

Results and Discussion

The result in Table 1 depicts that majority (84.1%) of cereal crop farmers in the study areas had experienced one forms of soil degradation or other. The study area is an agrarian society with over 400,000 farming households according to Niger State Ministry of agriculture (2012), thus activities of man and natural occurrences which constitute menace to land degradation over the years had enormously affected the productivity of the farmers. As result of the state contribution to food sustenance in Nigeria, efforts were put in place by several Governmental and Non-Government Organization such as Nigeria Institute of Soil Scientist to help conserve soil for improved productivity.

The study revealed that runoff (89.8%), waterlogging (78.9%) and soil structure destruction (75.3%) were the physical land degradation experienced by cereal crop farmers while low nutrient availability (96.5%) and increase soil acidity were the (72.1%) were the major chemical land degradation experienced by cereal crop farmers in the study area.This is similar to the findings of Onyerika, (2016) who opined that runoff and soil acidification were the major type of land degradation in the study area. Excess water that exceeds the amount that the soil can absorb usually results in runoff, which can wash away rich topsoil. Activities of man, like a poor irrigation and drainage system, as well as natural occurrences like floods, usually contribute to the runoff. Meanwhile waterlogging reduces aeration in the soil, thereby lowering oxygen levels in the root zone, which reduces plant growth.

Table 1: Types of land degradation (Physical and Chemical degradation)

Variables	Frequency	Percentage
Experience any land degradation in your farm	191	84.14
Physical		
Soil structure destruction	171	75.33
Dispersion of soil	59	25.99
Sealing of pore spaces	44	19.38
Low infiltration	62	27.31
Reduce root generation	51	22.4
Waterlogged	179	78.85
Runoff	204	89.87
Accelerated erosion	35	15.42
Compression, and increase density	5	2.20
Chemical		
Low nutrient availability	219	96.48
Low nutrient uptake	95	41.85
High mobility of element	39	17.18
Presence of toxic substances	12	5.29
Increased soil acidity	163	72.12
Salinity and sodicity	14	6.17
High level of alkalinity	43	18.94

Source: Field survey, 2022

Effects of land degradation on cereal crop production output

The result in Table 2 shows that soil nutrients loss ($\bar{X}$=4.5) was ranked first among the effects of land degradation on cereals crop output, this was followed by occurrence of soil erosion and reduction of crop yield ($\bar{X}$=4.3). Others include increased labour supply ($\bar{X}$=3.9), low output of farm produce ($\bar{X}$=3.9) and reduced labour productivity ($\bar{X}$=3.8). In addition, reduction of income ($\bar{X}$=3.7) and previous cultivated field abandon due to poor nutrient ($\bar{X}$=3.7) were perceived by cereals crop farmers as the effects of land degradation on their output.

Table 2: Effects of land degradation on cereal crop production output

Effects	Weight sum	Weigh mean	Rank	Decision
Occurrence of soil erosion which reduce soil nutrient	981	4.3	2nd	Agreed
Changes cropping system over the year	745	3.3	12th	Agreed
Recommended hybrid seeds are used during cultivation	834	3.7	8th	Agreed
Shifting cultivation has become less common	806	3.6	11th	Agreed
Previous cultivated field are abandon due to poor soil fertility	830	3.7	8th	Agreed
Farmers spend resources on how to improve their land	930	4.1	4th	Agreed
Low output of farm produce	886	3.9	5th	Agreed
Reduce farmers income	841	3.7	8th	Agreed
Reduce crop yield	971	4.3	2nd	Agreed
Increase labour supply	880	3.9	5th	Agreed
Reduce land productivity	859	3.8	7th	Agreed
Soil nutrient loss	1031	4.5	1st	Agreed

Source: Field survey, 2022

Adaptive strategies

The results in Table 3 revealed the adaptive strategies adopted by crops farmers to reduce the effects of land degradation on their output. The Table revealed that majority (87.2%) of the cereal crop farmers adopted terracing to reduce the menace of land degradation. Terracing is the practice of curving several, flat levelled areas in to hills steps which are bordered by a mud wall to prevent run off and holds the soil nutrients in the beds. The major advantage of terracing is that it reduces the water movement and its velocity thereby reducing soil erosion and permits more intensive cropping than would otherwise be possible. The other adaptive strategies adopted by cereal crop farmers in the study areas include mixed farming (68.7%), organic manure (63.9%), inorganic fertilizer application and afforestation (55.5%).

Table 3: Distribution of respondent according to adaptive strategies

Adaptive strategies	Frequency	Percentage (%)
Crop rotation	89	39.2
Mixed cropping	99	43.6
Mixed farming	156	68.7
Terracing	198	87.2
Zero tillage	67	29.5
Fallowing	51	22.5
Organic manure	145	63.9
Inorganic manure	126	55.5
Intercropping	62	27.3
Combination of organic and inorganic	90	39.7
Afforestation	126	55.5
Planting of grass	26	11.5
Stone line	48	22.2

Source: Field survey, 2022

Conclusion and recommendation

Based on the study, it can be concluded that land degradation constitutes menace to cereal crop production in the study area. Runoff, waterlogging and soil structure destruction were the physical land degradation experienced by cereal crop farmers while low nutrient availability and increase soil acidity were the chemical degradation associated with the study area. Furthermore, soil nutrients loss, occurrence of soil erosion and reduction of crop yield were the topmost effects of land degradation on cereal crop output. Terracing, mixed farming and the use of organic and inorganic manure were the adaptive strategies adopted by cereal crop farmers to mitigate against the effects of land degradation. The study recommended that cereal crop farmers should be sensitized by relevant stakeholders on the effects of their activities on the land which deplete soil nutrients and train on the best coping strategies for natural occurrences like flood.

REFERENCES

Akinnagbe, O. &Umukoro, E.(2011): Farmers' Perception of the effects of land degradation on agricultural activities in Ethiope East Local Government Area of Delta State, Nigeria. *Agricultural conspectus scientificus.*76 (2), 135 -141

Bankole, A. S., Adekoya, A. E., &Nwawe, C. N. (2012). Women's awareness and utilization of agroforestry practices in Oluyole Local Government Area of Oyo State, Nigeria. *International Journal of Agricultural Economics & Rural Development* (IJAERD), 5 (1), 95-103.

Niger State Ministry of agriculture (2012).. Road map to agricultural development in Niger state

Onyerika, A.I., (2016). Perceived effects of land degradation on agricultural production among farmers in Imo State, Nigeria.MSc thesis, Federal University of Technology Owerri. Accessed on 22/12/2020

Senjobi, B.A. And Ogunkunle, O.A. (2010). Effect of land use on soil degradation and soil productivity Decline on Alfi sols and Ultisols in Ogun State in South Western, Nigeria. *Agriculturae Conspectus Scientificus*. 75 (1), 9-19.

18 FUNCTIONAL PROPERTIES OF CASSAVA SEED PROTEIN CON

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ABSTRACT
Cassava seed is protein-rich; however, it is underutilized because it is less known, has high cyanide level and its functional properties are not studied. Functional properties are invaluable to the application of protein concentrate obtained from protein-rich seeds. The functional properties of cassava seed protein concentrate are reported in this work. The protein concentrate was prepared from defatted cassava seed flour samples using isoelectric precipitation extraction method. The proximate analysis and functional properties of the seed flour and the protein concentrate were carried out using standard methods. For proximate analysis, carbohydrate content was the highest and ash content was the lowest. The protein yield was 26.67%. The functional properties showed that water absorption capacity (WAC), oil, absorption capacity (OAC) and swelling capacity were higher than solubility index, least gelation capacity, and foaming capacity. Bulk density and viscosity are similar to results obtained from other seeds. The findings in this study showed that cassava seed protein concentrate may be relevant in the formulation of complementary foods, they may serve as good ingredient in sausage production industries where protein usually bridges the fat and water to obtain good products. Cassava seed would also be useful in dish washing liquids formulation industries and baking industries.
Keywords: cassava seed, protein concentrate, functional properties, proximate analysis, protein yield.

INTRODUCTION
Cassava is a major staple food in developing world and many sub-Saharan African countries (FAO, 2019). Cassava can be multiplied vegetatively from stem, meristem, leaf-bud and root-tip cuttings, or sexually from botanical seed (Hedge *et al*., 2016). Besides, cassava seeds are protein rich and thus, protein concentrates can be obtained from them. Protein concentrates are high protein content, obtained when non-protein components are eliminated from food through solvent extraction (Sibt-e-Abbas *et al*., 2015). Protein concentrate can be added to existing food products, markedly improving the nutritional quality without significantly altering other characteristics, moreover, in some instances, the addition appears to improve the shelf life of final products. In many developing countries, the supply of animal protein cannot adequately meet the protein needs of the rapidly growing population. Increase in cost of animal protein sources have accelerated research on food properties and potential utilization of alternative plant protein from locally available crops at a lower cost of production (Cheng *et al*., 2019). Since the values of cassava seeds are unknown, this research was carried out to investigate the potential of cassava seed protein concentrate as a food supplement through analysis of its nutritive value and function properties.
OBJECTIVE
To determine the proximate composition of cassava seed and functional properties of cassava seed protein concentrate.

MATERIALS AND METHODS

Source of Material

Cassava seeds were purchased from IITA Ibadan, Oyo State.

Determination of Proximate Composition

Moisture content, total ash content, crude lipid content, and crude protein content were determined using AOAC methods (AOAC, 2012).

Preparation of Protein Concentrate

The method of Chandi & Sogi (2007) was adopted in the preparation of cassava seed protein concentrate. The obtained protein isolate was then freeze-dried and packaged for further analysis.

Determination of Functional properties

Bulk density, swelling capacity and solubility index, Water and oil absorption capacity, gelation capacity, Viscosity, foaming capacity were determined using the method described by Onwuka (2005).

Statistical Analysis

Statistical analysis was performed using SPSS version 22.0. T-test and one-way analysis of variance (ANOVA) tools were used where required. All data was analyzed at 95% confidence interval and values were considered statistically significant at $p \leq 0.05$.

RESULTS AND DISCUSSION

The proximate compositions of cassava seed flour (Table 1) indicates that carbohydrate content of cassava seed flour was the highest compared to moisture, ash, crude fiber, crude protein and oil content. The lower moisture contents observed in raw cassava seed flour (Table 1) may enhance the shelf stability of the cassava seed flour by preventing the growth of microorganisms during storage (Godswill, 2019). The high ash content of cassava seed suggests that cassava seed may be a good source of minerals. Cassava seed flour has high crude fibers, which may improve bowel function and enhance faecal bulk digestion. The high crude fibre contents may be due to the presence of the hulls (DePeters *et al.*, 2020). Cassava seeds contain appreciable level of oil (Adunni, 2017), suggesting that they can be exploited as source of vegetable oil like the peanuts and soybean seeds. However, the oil content in cassava seed flour falls within the range (12.40-21.60%) of oil contents of conventional oilseed crops. the crude protein content is within the normal range of protein content of legumes (20 - 25%) reported by Erbersdobler *et al.*, (2017) and Maphosa and Jideani, (2017) thus, it may potentiate the use of cassava seed flour as source of protein in some food formulations. carbohydrate was the highest macro nutrient in cassava seed. The high content of cassava obtained in this study makes it an energy giving source; providing accessible fuel for physical performance and other body functions. Figure 1 shows the percentage protein yield and recovery. The result shows that the percentage protein yield and recovery were 26.67% and 84.31% respectively.

Table 2 shows that the water absorption capacity (WAC), oil, absorption capacity (OAC) and swelling capacity were higher than bulk density, solubility index, viscosity, least gelation capacity, and foaming capacity. Low bulk density is important in the formulation of complementary foods for infants feeding to enhance digestibility (Fasuan *et al.*, 2017). Therefore, the low value of bulk density obtained from this study makes the samples suitable for formulation of complementary foods. The result showed that CSPC, has high values of water absorption capacity (WAC) and oil absorption capacity (OAC). high water absorption capacity (WAC) and oil absorption capacity (OAC) of cassava seed protein concentrate (CSPC) give it amphipathic properties which would make it a good ingredient in cold meat industry, particularly for sausages, where the protein usually bridges the fat and water to obtain good products (Jain *et al.*, 2019). The low foaming capacity was probably due to low solubility, since high protein solubility is a prerequisite for achieving better foaming capacity (Dhanabalan *et al*. 2020). The low foaming capacity of Cassava seed protein concentrate obtained in this study would be useful in product formulation requiring low product foaming like dish washing liquids for machines (Toedt *et al*., 2005 Clendennen and Boaz, 2019). The low solubility of CSPC could be attributed to the fact that, it was extracted at the product's isoelectric point (James *et al*., 2016). Therefore, the pH or other solubility enhancing properties of CSPC can be further modified to improve its solubility and enhanced application in the food industry. The low level of least gel capacity obtained in this study would be useful as a substitute to other proteins in food applications and in new product development to form gels and provide a structured matrix for holding water, flavors, sugars and food ingredients, thereby providing an added dimension to protein functionality (Lin *et al*., 2020). High viscosity obtained in this study, can be due to the high-water absorption capacity of CSPC as shown in (Table 2) Therefore, for cassava seed protein concentrate, high viscosity will be necessary for foaming stability, especially as it has low foaming capacity.

Table 1: Proximate compositions of flours from raw and defatted cassava seeds

Proximate constituents	Cassava seed flour composition (%)
Moisture	9.89 ± 0.16
Ash	4.20 ± 0.23
Oil	20.75 ±2.66
Crude protein	16.64 ± 0.46
Crude fiber	11.94 ± 2.10
Carbohydrate	35.03 ± 5.73

Values are means of triplicate determinations ± SD.
Values along rows with different superscripts are significantly ($p \leq 0.05$) different.

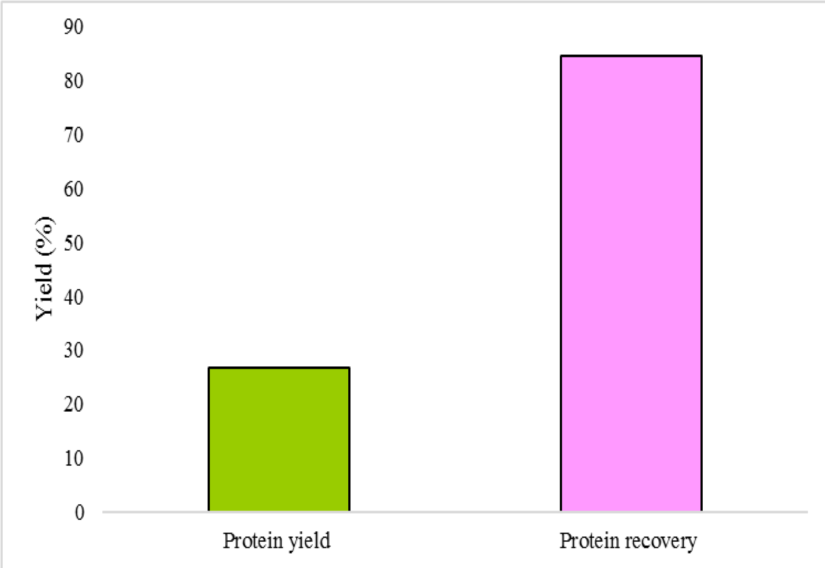

Figure 1: Protein Yield and Recovery from Cassava Seed Flour

Table 2: Functional properties of cassava seed protein concentrate.

Parameter	Functional properties
Bulk density (g/ml)	0.75 ± 0.78
Water absorption capacity (%)	250.77 ± 16.90
Oil absorption capacity (%)	209.81 ± 4.64
Swelling capacity (%)	277.18 ± 16.97
Solubility index (%)	6.68 ± 1.04
Least gel capacity (%)	17.00 ± 1.15
Foaming capacity (%)	5.50 ± 2.12
Viscosity (mpa.s)	56.25 ± 4.65

Values are means of triplicate determinations ± SD.

CONCLUSION

Cassava seed was found to be rich in protein. In addition, the functional properties of cassava seed protein concentrate can lead its possible relevance in food formulation industries.

References

Ooi, D. J., Iqbal, S., & Ismail, M. (2012). Proximate composition, nutritional attributes and mineral composition of Peperomia pellucida L.(Ketumpangan Air) grown in Malaysia. *Molecules*, *17*(9), 11139-11145.

Domínguez-Tejo, E., Metternicht, G., Johnston, E., & Hedge, L. (2016). Marine Spatial Planning advancing the Ecosystem-Based Approach to coastal zone management: A review. *Marine Policy*, *72*, 115-130.

Sibt-e-Abbas, M., Butt, M. S., Sultan, M. T., Sharif, M. K., Ahmad, A. N., & Batool, R. (2015). Nutritional and functional properties of protein isolates extracted from defatted peanut flour. *International Food Research Journal*, *22*(4), 1533.

Montoya-Camacho, N., Marquez-Ríos, E., Castillo-Yáñez, F. J., Cárdenas López, J. L., López-Elías, J. A., Ruíz-Cruz, S., ... & Ocaño-Higuera, V. M. (2019). Advances in the use of alternative protein sources for tilapia feeding. *Reviews in Aquaculture*, *11*(3), 515-526.

Otekunrin, O. A., & Sawicka, B. (2019). Cassava, a 21st century staple crop: How can Nigeria harness its enormous trade potentials. *Acta Scientific Agriculture*, *3*(8), 194-202.

al-Jouini, A. Q. S., & Naji, E. Z. (2019). Optimization for Extracting Iraqi Rice Bran Proteins Cultivar Yasmin and study some of Its Functional Properties. *Tikrit Journal for Agricultural Sciences* 64-49), 3(*18* ,□□□□□□□□□ □□□□□□□ □□□□□□ □□□□□.

Onwuka, G. I., & Onwuka, N. D. (2005). The effects of ripening on the functional properties of plantain and plantain-based cake. *International Journal of Food Properties*, *8*(2), 347-353.

DePeters, E.J., Swanson, K. L., Bill, H. M., Asmus, J., & Heguy, J.M (2020). Nutritional composition of almond hulls. Applied Animal Science, 36(6), 761-770.

19 EFFECTS OF INSURGENCY ON CROP FARMING ACTIVITIES OF RURAL WOMEN IN ADAMAWA STATE, NIGERIA

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ABSTRACT

The study analyzed the effect of insurgency on agricultural activities of rural women in Adamawa State, Nigeria. Multi-stage sampling technique was used to select 232 rural women involved in agricultural production in which semi -structured questionnaire complemented with interview schedule was employed to collect primary data. Data collected were analyzed using descriptive statistics (such as means, percentages, frequency counts and attitudinal measuring scale such as Likert type rating scale) and inferential statistics (such as, OLS and Gini Coefficient) the outcome of the accessibility of production inputs after insurgency showed that, cutlass ($\bar{X}$=2.43), hoe ($\bar{X}$=2.25), herbicides ($\bar{X}$ = 2.13), fertilizers ($\bar{X}$ = 2.03) and improved seeds ($\bar{X}$ = 2.03) were highly accessible by respondent. The result of the calculated Gini-coefficient was 0.53 which is close to one; this implies that there is inequality in income distribution among rural women in the study area. Regression analysis results revealed that farm size (0.2081), education (0.2081) and years of farming experience (0.6093) to be positive and significant while insurgency activities, loss of farmlands, lost of assets, lost of animals, relocation and frequency of attack were found to be negative and significant. This study recommended that, adequate sensitization of the rural women who are the most vulnerable victims of insurgency and the need for Adamawa State Ministry of Agriculture to establish a rehabilitation and training centre (skills acquisition programme) for victims of insurgency

KEY WORDS: Insurgency; women; farming; rural; input

INTRODUCTION

Agriculture plays significant roles in Nigeria economy in terms of rural employment, self-sufficiency in food, fiber, and export earnings before the discovery of oil (Towobola *et al*., 2014). In Nigeria, studies on women roles in agriculture have shown that women play a vital role in different aspects of income generation activities such as farming and non-farming operations. Women perform larger percentage of households' social, economic and cultural activities, they contributed to national and economic growth, even though not well documented statistically (Food and Agriculture Organization (FAO), 2011). Rural women play significant role as producers of food for the maintenance of the family. However, the incidence of insurgency has destabilized agricultural and socio-economic activities of the nation (Adebayo, 2014). The instability generated by the insurgency has caused substantial decrease in agricultural production (Ojo *et al.*, 2018). The From the inception of insurgency in the Northern part of the country in 2009 and its first attack in Adamawa State in 2011, few studies (Babagana *et al.*, 2018; Ojo *et al.*, 2018) have revealed serious negative effect on crop production activities. However, there is dearth of empirical evidence on the impact of insurgency on the outputs of women crop farmers in Adamawa State. This has constituted a gap in knowledge that needed to be filled. It is against this backdrop that this research was conceived to assess the effects of insurgency on crop farming activities of rural women in Adamawa State, Nigeria. The specific objectives of the study are to: assess the level of rural women access to production inputs in the study area; determine the pattern of income distribution among the rural women and determine the effects of insurgency on crop output of rural women.

METHOLOGY

The study was conducted in Adamawa State, Nigeria. Adamawa State is one of the States that was formed on the 27th of August 1991. It is located between Latitude 7º11' North of the equator and Longitude 11º14' East of the Greenwich meridian. The State has human population of about 3,168,101 according to 2006 population census(NPC, 2006). The population was projected to be 4,283,270 in 2017 at 3.2% annual growth rate (National Bureau of Statistics (NBS), 2015).

Three- stage sampling technique was employed to select 232 rural women in the study area using Taro Yammane model as used by Sunday *et al.* (2015). Primary data were elicited from the respondents using semi-structured questionnaire complemented with interview schedule. Data were analyzed using descriptive statistics such as means, percentages, frequency counts and attitudinal measuring scale such as Likert rating scale and inferential statistics(such as, OLS and Gini Coefficient and attitudinal measuring scale such as scale).

RESULTS AND DISCUSSION

Level of accessibility of inputs by women farmers

The respondents' level of access to agricultural production inputs in the study area are presented in Table 1. The result revealed that the respondents had high access to cutlass ($\bar{X}$=2.43) which ranked 1st among the production inputs. This was followed by hoe ($\bar{X}$=2.25) and ranked 2nd. This implies that the rural women farmers had high access to cutlasses and hoes. This is expected because cutlasses and hoes are among the oldest farming inputs commonly found with farmers especially in Nigeria and other developing nations. High accessibility to herbicides ($\bar{X}$ = 2.13), fertilizers ($\bar{X}$ = 2.03) and improved seeds ($\bar{X}$ = 2.03) ranked 3rd, 4th. and 5th respectively. This implies that access to agricultural inputs by women farmers was not highly affected by the insurgency in the study area this is in line with Umar *et al*. (2019) who reported similar findings.

Table 1: Levels of accessibility to production inputs by respondents

Level of Accessibility	HA	A	NA	WS	WM	Rank	Remarks
Cutlass	142	47	43	563	2.43	1st	Accessible
Hoe	121	49	62	523	2.25	2nd	Accessible
Herbicides	54	154	24	494	2.13	3rd	Accessible
Improved seeds	50	138	44	470	2.03	4th	Accessible
Fertilizer	33	172	27	470	2.03	4th	Accessible
Pesticides	75	59	98	441	1.90	6th	Poorly Accessible
Plough	24	51	157	331	1.43	7th	Poorly Accessible
Knapsack sprayer	17	45	170	311	1.34	8th	Poorly Accessible
Pumping machines	18	41	173	309	1.33	9th	Poorly Accessible
Ridger	16	39	177	303	1.31	10th	Poorly Accessible

Source: Field Survey, 2019. Note: HA = Highly Accessible (3), A = Accessible (2), NA = Not Accessible (1), WS = Weighted Sum, WM = Weighted Mean

Income Distribution among the Respondents

The pattern of income distribution among the respondents in the study area was achieved using Gini-coefficients. As revealed in Table 2, the calculated Gini-coefficient was 0.53 which is close to one. This implies that there was inequality in the distribution of income among the rural women in the study area. This could be associated with insurgency in the area as most of the rural women are displaced from their various homes depriving them access to farmland to carry out their agricultural activities. Low yield is associated with low income generation except those that have other sources of income from non-farming activities which could actually lead to income variation among the rural women farmers. This finding is in corroboration with Ayinde *et al.* (2012) who obtained a Gini-coefficient of 0.59 and 0.67 for agricultural and non-agricultural incomes respectively.

Table 2: Distribution of respondents based on their income generation

Income (₦)	Frequency	Proportionof respondents (X)	Cumm. Proportion of incomes (Y)	XY
< 200,001	29	0.13	0.04	0.00
200,001 - 400,000	29	0.13	0.10	0.01
400,001 - 600,000	46	0.20	0.25	0.05
600,001 - 800,000	36	0.16	0.42	0.06
800,001 - 1,000,000	46	0.20	0.69	0.14
> 1,000,000	46	0.20	1.00	0.20
Total	232	1.00		0.47
GI				0.53

Source: Field Survey, 2019

Effects of Insurgency on Crop Production

Regression analysis result presented in Table 3, reveals t the coefficient of determination (R^2) value as 0.7563 implying that about 76% variation in the crop output of the rural women farmers was explained by the independent variables included in the model, the remaining 24% unaccounted for could be due to type error or other variables not captured in the model.

The coefficient of farmland lost (-0.3001) was negative and significant at the 0.01 probability level; implying that a unit increase in loss of farmland will lead to 0.30 decrease in crop output of the respondents. This has the expected *a prior this is be*cause land is one of the important factors of agricultural production thus any activity that decreases land availability will invariably affect the total output. The reason for this result could be attributed to the fact that land meant for farming is used as the hideout of the insurgent thereby rendering the land unutilized.

The coefficient of animals lost (-0.2447) was negative and significant at the 0.01 probability level; implying that a unit increase in loss of animals will leads to 0.2447 decrease in crop output of the respondents. Animals such as donkeys, horse, ox and cattle as well as poultry dungs aid crop production. Apart from providing the needed cash after sales to procure inputs, they play one role or the other especially in supplying organic manure. Majority of the farmers lost their animals due to activities of insurgency which had negative effects on crop production in the study area.

The coefficient of assets lost (-0.5605) was negative and significant at the 0.01 probability level; implying that a unit increase in loss of assets especially production assets will lead to 0.5605 decrease in crop output of the farmers. Production assets like plough, ridger and other equipment are very key to crop production. In most cases, farmers were deprived of using them due to activities of insurgency which will in turn have negative effects on crop production of the rural women farmers.

The coefficient of relocation (-0.1449) was negative and significant at the 0.05 probability level; suggesting that a unit increase in relocation of farmers in the study area decreases their crop outputs. The activities of insurgency had forced many farmers to abandon farmlands and relocate to safer places. This act of relocation had negatively affected crop production activities and outputs of the rural women farmers in the study area.

The coefficient of frequency of attack (-0.7582) was negative and significant at the 0.01 probability level; implying that a unit increase in frequency of attack from insurgents decreases crop output of the respondents. The more the attacks from the insurgents, the more farmers abandon their farmlands use for cultivation and consequently affecting their production activities and output negatively in the study area.

The coefficient of people displaced (-0.1661) was negative and significant at 0.05 probability level; implying that a unit increase in people displaced will leads to 0.7582 decrease in crop output of the respondents. This meet the *a priori expectation.* Many of the respondents take refuge at IDP camps for safety, abandoning their original homes and farm lands which invariably leads to decrease in their crop outputs.

The coefficient of exposure to bomb (-0.2548) was negative and significant at 0.10 probability level; implying that a unit increase in exposure to bombs will lead to 0.2548 decrease in crop outputs of the respondents. This outcome is expected because, the more farmers are exposed to bombs, the more they abandon that location for safety.

Table 4.10: Regression estimate on effects of insurgency on crop production

Variables	Coefficients	T-value
Loss of farm land	-.3001	-2.89***
Loss of crops	.1096	1.39
Loss of animals	-.2447	-3.73***
Loss of asset	-.5605	-5.76***
Loss of lives	-.0596	-0.47
Relocation	-.1449	-2.25**
Frequency of attack	-.7582	-6.23***
People displaced	-.1661	-2.42**
Death of several farmers	-.0084	-0.09
Exposure to bombs	-.2548	-1.98*
Fear of being killed	.1502	0.90
Fear of abduction	.0501	0.40
Fear of attack	-.1268	-0.96
Constant	10.6271	13.15***
R-squared	0.7563	
Adjusted R-squared	0.7239	
F-ratio	14.07***	

Source: Field Survey, 2019

Note: *** implies significant at 0.01, ** significant at 0.05%, * significant at 0.10%.

CONCLUSION AND RECOMMENDATION

Based on the study it can be concluded that cutlass, hoe, herbicides, fertilizers and improved seeds were highly accessible by the respondent. More so, there is inequality in income distribution among rural women in the study area. In addition, farm size, education and years of farming experience had direct relationship with crop production while insurgency activities, loss of farmlands, lost of assets, lost of animals, relocation and frequency of attack had inverse relationship with crop production by rural women. The study recommended that, adequate sensitization of the rural women who are the most vulnerable victims of insurgency and the need for Adamawa State Ministry of Agriculture to establish a rehabilitation and training centre (skills acquisition programme) for victims of insurgency

REFERENCES

Towobola, W. L., Luqman, R., Kolade, T. T., Ogunwale, A. B. & Olakojo, S. A. (2014).Entrepreneurship: A vehicle for sustainable food production in Nigeria. *Journal of Poverty, Investment and Development*, 5, 23 – 24

Jongur, A. A. U. (2011). Performance of agricultural cooperative societies in Mubi zone of Adamawa State.*Global Journal of Agricultural Sciences*, 10(2), 119 – 126.

Fontana, M. & Paciello, C. (2010).Gender dimensions of rural and agricultural employment: differential pathways out of poverty: *a global perspective. in gender dimensions of agricultural and rural employment: differentiated pathways out of poverty. FAO/IFAD/ILO, Rome*

Adebayo, A. A., Onu, J. I., Adebayo, E. F. & Anyanwu, S. O. (2012). Farmers' awareness, vulnerability and adaptation to climate change in Adamawa State, Nigeria. *British Journal of Arts and Social Sciences*, 9 (2), 104 – 115.

Food and Agriculture Organization (FAO) (2011).The state of food and agriculture-women in agriculture: closing the gender gap for development, Rome. Available at: http:www.fao.o rg/docrep/013/12050c/12050c.pdf.Accessed on 16/12/2018.

Beatrice, E. A. (2015). Book Haram insurgency and the underdevelopment of Nigeria.*Research on Humanities and Social Sciences*.5(6), 213 - 220

Ojo, M. A, Usman, M. A. Mohammed, U. S, Ojo, A. O. & Oseghale A. I. (2018). Effect of insurgency on food crop farmers' productivity in Borno and Gombe States, Nigeria. *Journal of Agriculture,* 30 (3), 43 – 55

Babagana, M., Ismail, M., Mohammed, B. G., Dilala, M. A., Hussaini, I. &Zangoma, I. M. (2018).Impacts of Boko Haram insurgency on agricultural activities in Gujba Local Government Area, Yobe State, Nigeria.*International Journal of Contemporary Research and Review*, 9(12), 20268 – 20282.

20 ADOPTION OF BIO-FORTIFIED FOOD CROP IN NIGERIA: A REVIEW

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Abstract

Micronutrient deficiency is a form of malnutrition which occurs as a result of low micronutrient in our diet, most of the traditional staple foods consumed in Nigeria are low in micronutrients. Micronutrient deficiency has also been attributed to poor processing and handling of food resulting in nutrient loss, lack of consumption of fruits and vegetables and high cost of nutritious foods. The introduction of micronutrients in our staple food through crop breeding resulting in food crop rich in micronutrients has proven to be cost effective and a long term solution to remedying micronutrient deficiency. Previous studies have revealed a relationship between socio-economic factors such as age, household size, education, extension, awareness and farmer associations. However, there is need for further study on the adoption of various bio-fortified food crops as most of existing are studies cantered on the adoption of bio-fortified cassava. This studies would take into cognizance socioeconomic determinant affecting the adoption of bio-fortified food crops especially crop specific determinants.

Keywords: Adoption, Biofortified, Micronutrient, Deficiency, Malnutrition, Food,

Introduction

The world is faced with various health challenges affecting people across developed and developing countries, malnutrition and hunger has been identified as one these challenges. there are 11 million people undernourished in developed countries and almost all the hungry people, 791 million, live in developing countries, representing 13.5 percent, or one in eight, of the population of developing counties (FAO 2015). In Nigeria, Global Hunger Index (GHI) 2022 reported an index score of 27.3 implying hunger is a serious problem in the country with 12.7% of the population undernourished (Global Hunger Index 2022). One of the forms of malnutrition occurs as a result of deficiency of micronutrients called micronutrient deficiency or hidden hunger. This results in poor immune system function, stunting, wasting, limited cognitive development and iron deficiency anemia (Onuegbu *et al.*, 2022). Micronutrient deficiency is a result of suboptimal diets, consumption of staples food with low micronutrient, poor processing and handling of food resulting in nutrient loss lack of consumption of fruits and vegetables, high cost of nutritious foods.

Micronutrient deficiencies contribute significantly to child mortality worldwide, and annual vitamin A and zinc deficiencies are estimated 600,000 and 400,000 deaths respectively (Annim, *et al.*, 2022). It has been estimated that 25% of children under six years of age in Nigeria suffer from vitamin A deficiency. This may result in poor growth, impaired vision, and impaired epithelial integrity (Nguema, 2010). Statistical facts available shows a huge gap exist in meeting the nutritional requirement in Nigeria. Despite the progress recorded in controlling micronutrient deficiencies through supplementation and food fortification, new approaches are required, especially to reach the rural poor a better approach to control vitamin A, iron, and zinc deficiencies of staple food crops in poor countries known as bio-fortification.

Bio-fortification is the process of breeding food crops that are rich in micronutrients, such as vitamin A, zinc, and iron. It refers to technologies for enhancing, through biological processes such as breeding and transgenic techniques, the micronutrient content of staple foods.

Adoption of bio fortified food crops by farmers.

Although there have been several attempts by government in amending the issue of malnutrition, some of these programmes are expensive with short term benefits. Bio-fortification of staple food crop has been identified as less expensive and long term solution to remedying malnutrition. Since the introduction of bio-fortified food crops to farmers, there is a need to understand the adoption rate and factors affecting the adoption of bio-fortified food crop among farmers. by so doing, socioeconomic attributes aiding or inhibiting the adoption of bio-fortified food crops are identified, some of the factors affecting the adoption of bio-fortified foods and recurrent in previous studies are elaborated below.

Table 1. Determinants of Adoption of Bio-fortified Food Crop

Determinants	Number of paper mentions	
	Positive relationship (+)	Negative relationship(-)
Household size	2	1
Age	-	4
Education	4	2
Extension	7	-
Farmers Association	5	-
Awareness	4	-

Source: Author's categerization

Household size: the size of household affects farming decisions such as farm size, labour use, and

crop to be cultivated; studies have revealed a significant relationship between household size and adoption bio-fortified food crops. Studies of Abdoulaye *et al.*, (2015) and Uwandu *et al.*, (2019) have revealed positive relationship between household size and adoption of bio-fortified food crop. However, Oyeneke *et al.*,(2020) in their study discovered a negative relative relationship between household size and Bio-fortified food crop.
Age: the years of existence of a farmer has had significant relationship with adoption of modern technology or innovation, most times age plays a complementary role with experience as it is assumed older age comes with more experience of farming. Adoption of innovation is lesser among farmers of older ages. Previous studies have shown a negative relationship between age and adoption of bio-fortified food crops (Abdoulaye *et al.*, 2015; Ayodele *et al.*, 2020 Kolapo *et al.*, 2020).

Education: educational attainment is vital in dissemination of new farming technologies as it helps the farmer in understanding intricacies and complexities that comes with adoption. Uwandu *et al.*,(2019) in their study revealed a positive relationship between education between education attainment and adoption of bio-fortified food crops. This was affirmed by findings of Oyeneke *et al.*,(2020) and Abdoulaye *et al.*, (2015). However, Kolapo *et al.*, (2020) reported a negative relationship between education and adoption of bio-fortified food crop.
Extension: at the heart of disseminating new technology is an Agricultural extension service bridging the gap between manufacturers or inventors of new technology and farmers. Ayodele *et al.*, (2020) in a study aimed at examining the determinants of adoption of bio-fortified cassava among farmers in South West Nigeria affirmed a positive relationship between extension delivery and adoption of bio-fortified food. This was further affirmed by findings of Uwandu *et al.*, (2019) and Ayinde *et al.*, (2017).

Farmers association: groups of farmer sharing mutual interest in the form of farmers' association or cooperative societies are often a point of entry for inventors or manufacturers of modern agricultural technologies who wish to target farmers directly. In a study by Onyegbulam *et al.*, (2019) awareness had a positive relationship with adoption of bio-fortified cassava in Abia state Nigeria. This was consistent with findings of Ayodele *et al.*, (2020) and Oyeneke *et al.*, (2020)
Awareness: farmers being informed of a new technology is usually the first step of disseminating, increasing awareness through the use of various forms of media, increase the probability of adoption. This was affirmed by the findings of Kolapo *et al.*, (2020) Oyeneke *et al.*, (2020). This implies awareness has been effective in dissemination of Bio-fortified food crops
Conclusion
Previous studies on adoption of bio-fortified food crop by farmers reveals there exist a relationship between socioeconomic characteristics of the farmers and adoption. Also, agricultural extension services, and awareness had a strong relationship with adoption of bio-fortified food crops. However, there is need for further study on the adoption of bio-fortified various food crops as most of previous findings are on cassava, focus on the adoption of other bio-fortified food crops such as maize and potatoes would reveal certain determinants peculiar to a particular crop. Through a

gender tailored approach, understanding the gender differentials in adoption of bio-fortified food crops would reveal factors affecting adoption of bio-fortified food crops some of which may be gender specific.

Reference

Abdoulaye, T., Bamire, A. Oparinde, A. & Akinola, A. (2015). Determinants of Adoption of Improved Cassava Varieties among Farming Households in Oyo, Benue, and Akwa Ibom States of Nigeria. HarvestPlus Working Paper No. 20

Annim, S., Stranges, S., Kandala, N., & Amegah, A., (2022). Do dietary practices and household environmental quality mediate socioeconomic inequalities in child undernutrition risk in West Africa? *Journal of Public Health Nutrition*. 10.1017/S1368980022002269

Ayodele, O. V., Fasina, O. O. & Osundahunsi, O. F. (2020). Adoption of Biofortified Cassava Among Farmers in South West Nigeria: A Binary Logit Analysis of The Determinants *Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development* Vol. 20, (4) 2020 Pp 71-78.

De Groote, H., Gunaratna, N. Ergano, K. & Friesen, Dennis (2010). Extension and adoption of biofortified crops: Quality protein maize in East Africa. Paper presented at the joint 3rd African Association of Agricultural Economists (AAAE) & 48Th Agricultural Economists Association of South Africa.(AEASA) Conference Cape town, South Africa , September 19-23, 2010.

Food and Agricultural Organisation of the United Nations (FAO), 2015, International Fund for Agricultural Development (IFAD) and World Food Programme (WFP). 2016. The State of Food Insecurity in the World 2015. Meeting the 2015 international hunger targets: taking stock of uneven progress. Rome, FAO, *http://*www.fao.org/3/a-i4646e.pdf, Accessed on November 10, 2016.

Global Hunger Index(GHI)(2022). Global Hunger Index 2022:Nigeria https://www.globalhungerindex.org/nigeria.html, Accessed on November 21, 2022.

Kolapo A., Ologundudu O. M., & Adekunle I. A., (2020). Gender, Membership In Farmers‟ Association And Adoption of Biofortification In Nigeria: The Case of Bio-Fortified Cassava. *International Journal of Agriculture & Environmental Science*. 7(3)Pp38-45

Nguema, A., Norton G.W., Fregene, M., Sayre, R. & Manary, M. (2010). Expected economic benefits of meeting nutritional needs through biofortified cassava in Nigeria and Kenya. AfJARE 6: 1-17.

Onyegbulam L.A., Alleluyanatha, E ., Anyanwu C. P. & Mbanaso, J. A. (2017) Adoption and Commercialization of Biofortified Cassava roots in Abia state, Nigeria. *Journal of Sustainable Development 16 (12)* Pp 13- 22.

Onyeneke, R. U. Emenekwe, C. C., Munonye, J. O., Olaolu, M. Olatunji., Izuogu, C. U., Ibrahim-Olesin, S., Amadi, M. Umunna ., Njoku, C., L., Obi, J. N., Adoption of Bio-fortified Pro-Vitamin-A Cassava and Health Outcome of Farming Households in Abia and Anambra States Nigeria. *Journal of Agricultural Extension 24 (2)*

Uwandu QC, Amadi PE, Igwe COK. Determinants of degree of adoption of Pro Vitamin A Cassava varieties among farmers in Delta State, Nigeria. *Discovery*, 2019, 55(287), 578-582

Wellington, J., Temesgen, B. & Frederick, G. (2021). Factors influencing farmers' dis-adoption and retention decisions for biofortified crops: the case of orange-fleshed sweetpotato in Mozambique, Agrekon, 60:4, 445-459, DOI: 10.1080/03031853.2021.1956555

21 DETERMINANTS OF THE ADOPTION OF IMPROVED BEEHIVE TECHNOLOGIES IN BENUE STATE, NIGERIA

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Abstract

This study was carried out to assess the determinant of adoption of improved beekeeping technologies in Benue State. Three-stage sampling procedure was used to select 212 beekeepers; primary data were elicited from the respondents with the aid of a semi-structured questionnaire. Data were analyzed using descriptive statistics and logit regression model. The findings indicated beekeeping experience, household size, extension contact and membership of cooperative were the major determinant of improved keeping adoption in the study area while indiscriminate bush burning(97.5%), theft(91.5%), lack of beekeeping skills(76.9%), Lack of credit facilities(75.0%), where the major constraint faced by the beekeepers in the study area. The study recommends that effort should be geared toward providing extension services to beekeepers. Membership of cooperative society should be encouraged among beekeepers. Also, beekeepers should fire trace round their farm during at the onset of dry season to avoid adverse effects of bush burning on beekeeping.

Key words: Adoption, determinant, Bush burning, and Beekeeping

INTRODUCTION

Honey Bees are one of the most important organisms on earth, they belong to the family *Apoidae* and order *Hymenoptera* which includes honey bees, bumble bees, stingless bees, and carpenter bees. Although there are over 20,000 species of wild bees, the species usually managed by beekeepers is the western honey bee (*Apsimellifera adasonti*) and Nigeria in particular (Eforuoku and Thomas 2015). Bee keeping is the art and science of raising honeybees for man to benefit economically. The practice of beekeeping also referred to as apiculture dates back many years. There is evidence of people collecting honey from wild bees as far back as 15,000 years ago (Tew 2016).

Beekeeping is an industry that provides the ability for economically marginalised groups, such as landless poor and rural people, to access income without exacerbating environmental and land tenure problems (Schouten and Lloyd, 2019). Honey bees have great potential to be developed as a smallholder niche industry with low input costs and the ability to scale-up quickly. Bee products can be marketed through existing networks and bees in many cases improve productivity of crop-farming systems through improved pollination.

Beekeeping has evolved to be a very lucrative agricultural practice for local people in developing countries of the world. As an agricultural activity that may generate income all year round under suitable climate conditions of which Nigeria is one of the best country due to its vegetation and weather condition, apiculture provides more advantages for producers when compared with other agricultural activities. In spite of the importance of honey and its by-products from beekeeping, their contributions to rural income, Gross Domestic Product (GDP) and the economic development of nations including Nigeria, Beekeepers in Nigeria have relied on traditional beekeeping practice (Eforuoku and Thomas 2015). The practices of hunters and destructive bee keeping techniques which among them include the use of traditional equipment and harvesting technique which entail killing the bees in addition to low quality products are some of the disadvantages of traditional beekeeping practices (Ubeh *et al.*, 2021). This has led to decline in bee population and honey production below optimum output and quality. Hence this study investigates the determinants of the adoption of improved bee hive technologies in Benue State, Nigeria. Specifically, it aims to:

i. determine factors influence adoption of beehives technology
ii. identify challenges associated with beekeeping in the study areas.

Methodology

The study was carried out in Benue State. The State is one of the six states constituting the North Central region of Nigeria with its headquarters in Makurdi. Benue State is located between Latitudes $6^0$30'N and $8^0$10'N and Longitudes $6^0$33'E and 10^0E. Three-stage sampling technique was used in selecting bee farmers in the study area, the first stage was random selection of one local government form each of the three (3) agricultural zone in the state namely Buruku, Markudi and Otukpo. Second stage involved the random selection of three communities from each of the selected local government, proportionate sampling used in selecting farmers in the third stage of the sampling A total of 212 bee farmers were selected for the study. Primary data elicited from the respondents with the aid of a semi-structured questionnaire were used for the study; descriptive statistics was used to identify the constraints in beekeeping and binary logistic regression model was used to determine the factors affecting the adoption of improved beekeeping technologies.

Implicitly, the model is stated as

$Y = f(X_1, X_2 - - - - - - X_{13,}\ ei -$ (3)

Explicitly it is expressed as:

$Y = \beta_0 + \beta_1 MS + \beta_2 GD + \beta_3 ED + \beta_4 BE + \beta_5 HS + \beta_6 AC + \beta_7 EC + \beta_8 MC + \beta_9 BW + \beta_{10} NH + \beta_{11} CI + \beta_{12} SI + \beta_{13} AD + \beta_{14} TH + \beta_{15} BM + \beta_{16} AV + \beta_{17} AG + \mu$--------------------14

Where:

Y = (Adoption of at least one modern beehive technology 1 if otherwise 0)

β = estimated coefficient

$\beta_1 - \beta_{12}$ = Coefficient of explanatory variables

MS =Marital status (Married 1, if otherwise 0), GD = Gender (male 1, female 0), ED = Education (Years), BE = Beekeeping experience (Years), HS = Household size (Numbers), EC =Extension contact (Number of visit), MC = Membership of cooperative (Yes 1, 0 no), BW = Bee workshop (Yes 1, 0 no), AD =Area devoted foe beekeeping (ha) TH = Types of hives (Number), BM = Baiting material (Number), AV = Apiary visit (Yes 1, 0 no), AG = Age (years) Ui = error term

Results and discussion

Factors influencing adoption of improved beekeeping technologies

The findings in Table 1 shows that the pseudo R-squared was 0.2526 which shows a relatively good fit for the binary logit model while the chi-square results shows that the likelihood ratio statistics was statistically significant.

Table 1: Determinant of beehives adoption

Variables	Coefficient	Z-values
Marital status	1.6204	0.02
Level of education	1.033	0.79
Beekeeping experience	-.8666***	-5.33
Household size	-. 7903*	-1.99
Level of involvement	2.6495	1.58
Extension contact	-.5082**	-2.39
Membership of cooperative	3.5163****	2.92
Beekeeping workshop	.7666	-1.26
Types of baiting	1.1145	0.80
Types of bee hives	1.0397	0.52
Area devoted beekeeping	.7428	-1.28
Age	-.0163***	-2.88
Pseudo R squared	0.2526	
Log Likelihood	-150.40	
LR Chi squared	101.65***	

Source: Field survey, 2022

The coefficient for beekeeping experience (0.866) was negative and statistically significant at 0.01 probability level implying that a unit increase in beekeeping experience may likely leads to 0.866 decreases in adoption of beehives. This is against the *a priori* expectation, because increase in beekeeping experiences is expected to enhance adoption of innovation. This contradicts findings of Muya's (2014) findings, which suggested that experienced farmers were more willing to try new and difficult agricultural technologies. Furthermore, more experienced farmers may find it difficult switching to the use of modern beehive technologies due to years of using certain technology and bee farming methods.

Household size (0.7903) had a negative relationship with adoption and statistically significant at 0.10 probability level implying that a unit increase in household size may likely leads to 0.7903 decreases in adoption of beehives. This disagrees with the studies of Workneh (2011) and Bunde and Kibet (2015) who opined that family size has positive influence on adoption of modern technologies. The reason for this result could be attributed to the fact meeting physiological and other needs of the family may likely reduce the amount resources available to adopt the technology.

The coefficient for extension contact (0. 5082) was negative and statistically significant at 0.05 probability level implying that a unit increase in extension contact may likely leads to 0.5082 decreases in adoption of beehives. This is against the *a priori* expectation, because extension agent is expected to create awareness about new innovations which is expected to enhance adoption of such innovation. This contradicts the study of Amanuel (2018) who concluded that farmers who have access to extension services are more likely to embrace improved agricultural technologies. The reason for this result could be attributed to poor extension contact and inadequate subject matter specialist on bee farming in the study areas.

Membership of cooperative (3.5163) had positive relationship with adoption and statistically significant at 0.01 probability level implying that a unit increase in membership of cooperative may likely leads to increases in adoption of beehives. This is the *a priori* expectation and it is similar to the study of Ogunbameru *et al.* (2008) who argued that participation in cooperative have the potential of creating confidence between farmers and financial institutions thus allowing farmers to have access to farm credit from such institutions using their collective grains in a community warehouse as collateral. The reason for this finding could be attributed to high level of beekeeping cooperative in the study areas and the prevalent of social media which pave ways for easy communication among keepers.

Challenges of beekeeping

The results in Table 2 shows the challenges faced by beekeepers in the study areas. From the Table, Indiscriminate bush burning(97.2%), theft (91.5%), Lack of beekeeping skills (76.9%), lack of credit facilities(75.0%) major constraints faced by beekeepers in the study area. However, drought(16.5%) Low quality beekeeping materials (28.3%) Pest and diseases(33.0%) Lack of beekeeping materials (33.5%) were identified as the least constraints faced by beekeepers in the study area. The major constraints identified implies the presence of externalities in the form of indiscriminate bush burning and theft which results in loss of bees in the farm. Furthermore, the least constraints identified implies the presence of a conducive environment for beekeeping and availability of capital inputs needed for beekeeping.

Table 2: Distribution of respondent according to challenges of beekeeping

Variable	Frequency	Percentage	Rank
Fear of sting	133	62.7	7th
Pest and diseases	70	33.0	12th
Lack of beekeeping materials	71	33.5	11th
High cost beekeeping materials	153	72.2	5th
Lack of credit facilities	159	75.0	4th
Lack of beekeeping skills	163	76.9	3rd
Absconding of bees	139	65.6	6th
Indiscriminate application of agro-chemicals	123	58.0	8th
Labour shortage	87	41.0	9th
Low quality beekeeping materials	61	28.8	13th
Theft	194	91.5	2nd
Lack of storage facilities	84	39.6	10th
Bush burning	206	97.2	1st
Drought	35	16.5	14th

Source: Field survey, 2022

CONCLUSION AND RECOMMENDATION

Based on the study it can be concluded that beekeeping experience, household, extension contact and membership of cooperative were the determinant of adoption of improved beekeeping in the study areas while indiscriminate bush burning, theft, lack of beekeeping skills, high cost beekeeping materials, absconding of bees, fear of sting and indiscriminate application of agro-chemicals were the major constraint facing beekeepers while drought, Low quality beekeeping materials, Pest and diseases, Lack of beekeeping materials, were the least constraints faced by beekeepers in the study area. From the findings of the study the following recommendation were made.

1. Effort should be geared toward providing extension services to beekeepers.

2. Membership of cooperative society should be encouraged among beekeepers as farmer groups ease entry in dissemination of modern technology. hence, a target of technology dissemination.

3. Beekeepers should fire trace round their farm during at the onset of dry season to avoid adverse effects of bush burning.

4. Modern beekeeping equipment should be provided for beekeepers at subsidized rate or in form of credit with option of payment in installments.

REFERENCES

Amanuel, B. (2018). Review on adoption of modern beehive technology and determinant factors in Ethiopia. *Journal of Natural Sciences Research*, 8 (3), 2224-3186

Eforuoku, F. and Thomas, K. A. (2015). Effect of Training on The Use of Modern Beekeeping Technology in Oyo State, Nigeria. Nigerian Journal of Rural Sociology 15 (2) Pp 61-66

Muya, I. B. (2014). Determinants of adoption of modern technologies in beekeeping projects: the case of women groups in Kajiado County, Kenya. (Master's Thesis). Retrieved from http://erepository.uonbi.ac.ke/handle/11295/72341

Oladimeji, Y. U., Abdullahi, A. N., Abdulsalam, Z. & Damisa, M. A. (2017). Adoption of improved technologies and Management Practices Among Bee Farmers in North Central and North Western NigeriatowardsSustainableDevelopment Goals. *Ethiopia Journal of Applied Science & Technology, 8 (1), 1-13*

Olatade, K. O., Olugbire, O. O., Adepoju, A. A., Aremu, F. J. & Oyedele, P. B. (2016). How does farmers' characteristics affect their willingness to adopt agricultural innovation? The case of bio-fortified cassava in Oyo State, Nigeria. *International Journal of science and Technology*, 5 (2), 59-75.

Shakib, V. & Sayed, M., E. (2016). Profitability and Socio-economic analysis of beekeeping and Honey Production in Karaj State, Iran. *Journal of Entomology and Zoology Studies 4 (4), 1341-1350*

Taha, M. (2007). Determinants of intensity of adoption of improved Onion Production Package in Dugda Bora District. *(Unpublished MSc. Thesis), Haramaya University, Haramaya, Ethiopia*

Ubeh, E., Umunakwe, P.C., Aja, O. O., Chukwu-Okonya, R.C and Ibe, M.A. (2021). Analyses of Use of Improved Beekeeping Equipment Among Agricultural Development Programme Registered Bee Farmers in Imo State, Nigeria. *Nigerian Agricultural Journal* 52 (2) Pp215-220.

Workneh, A. (2011). Financial benefits of box hive and the determinants of Its Adoption in Selected District of Ethiopia *American Journal of Economics, 1 (1), 21-29*

World Bank (2015). Poverty our Africa: google search. Retrieved from www.worldbank.org/poverty/report/http on 31st January, 2016

RISK ANALYSIS OF CEREAL/LEGUME FARMERS IN NIGER STATE, NIGERIA

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Abstract
This study describes the socio-economic characteristics of the cereal/legume farmers in Niger State, Nigeria, identify risk associated with cereal/legume enterprise; determine the risk attitude of the farmers and identify the management strategies employed in minimizing risk associated with cereal/legume enterprise in the study area. Multistage sampling technique was used for the selection of two Local Government Areas (LGAs) from each of the three agricultural zones I, II, and III, respectively. Farming communities were randomly selected from each of the sampled LGAs from which respondents were proportionately selected to make a total of 296 respondents for this study. Primary data was collected with the aid of structured questionnaire and interview schedule. The data collected were analysed using descriptive statistics, Safety-first and factor analysis. The result showed that the mean age of the farmers was 41 years and about 86.4% of them were members of cooperative society. About 59% of the cereal/legume farmers was risk averse and only about 5.4 per cent of them was risk preferring. Production risk claimed about 90.5% of all risks associated with cereal/legume enterprise in the study area. Spreading sale (selling at different period), *family member working off-farm and early planting of crops were employed for managing risk in the study area. It is recommended that Government in conjunction with the donor agencies should make provision for interest free credit facilities to the farmers at the appropriate time to enable them take as much risk as possible to increase their Cereal/Legume production.*

Keywords: Risk, Analysis, Cereal, Legume, Farmers

Introduction

Agricultural production is subject to risk and the attitudes of producers toward risk influence input choices as long as it affects production (Picazo-Tadeo *et al.*, 2011). Un-like other economic activities, agricultural enterprises are faced with so many risks and uncertainties such as input supply and prices, post-harvest losses and product prices, extreme weather conditions as well as pests and diseases (Nmadu *et al.*, 2010). Other natural hazards such as floods and fire outbreaks are equally important with regards to their impact on the success or failure of an agricultural enterprise (Aina *et al.*, 2012). Furthermore, risk and uncertainty are basic to any decision- making framework due to the fact that, risk is an imperfect knowledge where the probabilities of the possible outcomes are ascertained.

Lack of clear understanding of farmers' attitudes towards risks remains an important factor inhibiting increased agricultural productivity. Increasing crop production to take advantage of ban on crop importation largely depends on the risk attitude and risk management strategy of the farmers. Therefore this research described the socio-economic characteristics of the cereal/legume farmers in Niger State; identify risk associated with cereal/legume enterprise; determine the risk attitudes of the farmers and, identify the management strategies employed in minimizing risk associated with the enterprise in the area.

Methodology

Study Area

Niger State has its headquarters in Minna, comprising of 25 Local Government Areas. These are further divided into three agricultural zones namely; zones I, II and III. The State is located in the North-Central zone of Nigeria between Latitudes 8^o N´ and 11^o 20N´ and Longitudes 4^o 30^{1}´ E and 7^o 40^1 E. It shares common boundaries with Zamfara State to the North-West, Kaduna State to the North-East, and Federal Capital Territory to the South-East. The main occupation of the people of the State is farming which is the back bone of her economy, employing over 80 per cent of the total population in the State. It is endowed with 8.3 million hectares of land which allows for the production of staple food crops, vegetation for grazing, production of fishery and forestry. The State experiences mean annual rainfall of between 1,100mm and 1,600mm per annum and temperatures of not more than 94F between March and June and not less than that, between December and January (Niger State GIS, 2020).

Sampling Techniques and Method of Data Collection

The study employs multistage sampling technique for data collection. The first stage involves the random selection of two Local Government Areas (LGAs) from each of the three agricultural zones. In the second stage, farming communities were randomly selected from each of the sampled LGAs and the third stage involved the random selection of respondents from each of the sampled communities proportionate to their frames following (Tanko and Kpange, 2014), as in equation (1) to give a total of 296 respondents for this study. Primary data were collected with the aid of structured questionnaire complemented with interview schedule and administered by the researchers and trained enumerators to elicit relevant information from the respondents.

$$nh = \frac{n.Nh}{N} \qquad 1$$

Where: nh = sample size to be determined, n = targeted number of respondents, Nh = sample frame (total number of farm households in each community), N = finite population (total number of farm households in the study area).

Method of Data Analysis

The data were analysed with the use of descriptive statistics such as frequency distribution and percentages to describe the socio-economic characteristic of the farmers, Safety-first approach for determining the risk attitude of the farmers while factor analysis was used in the determination of risk management strategies employed by the farmers.

Table 1: Sampling frame and sample size of cereal/legume producers in Niger State

Sampled State	Agricultural Zone	Selected LGAs	Sampling frame	Sampling size
Niger	I	Mokwa	29,240	85
		Katcha	23,891	69
	II	Paikoro	9,450	27
		Gurara	8,281	24
	III	Wushishi	9,525	28
		Kontagora	21,238	62
Total			101,625	296

Source: Niger State GIS (2007)

Specification of factor analysis model

The safety-first behavioural approach was used to generate risk aversion parameter (Ks) for each respondents following Sadiq *et al.* (2018) as expressed below:

$$L_s = \frac{1}{\theta}\left[1 - \frac{R_k N_k}{R_z \beta_k \mu_z}\right] \qquad 2$$

Where; Ls is the risk index of k^{th} farmer, θ is variance parameter; R_k is the unit price of the chosen most influential input for K^{th} farmer; N_k is quantity of the chosen most influential input of the K^{th} farmer; R_z is the unit price of the output of K^{th} farmer; B_k is the elasticity coefficient of output with respect to the chosen input; and, μ_z is the mean of the output. Following Sadiq *et al.* (2018), the risk aversion parameter Ls was used to classify farmers into three distinct categories as expressed below;

$0<Ls<0.4$ = Low risk aversion/Risk preference

$0.4<Ls<1.2$ = Intermediate/moderate risk aversion/Risk neutral

$1.2<Ls<2.0$ = High risk aversion/Risk aversion

Factor analysis was used to determine the risk management strategies for the cereal/legume based farmers. It conceived that standard parametric statistical measures are suitable for ordinal variables in the form of Likert-type scale (1 not important, 2 less important, and 3 very important) (Jirgi, 2013). It reduces attribute space from a larger number of variables to a smaller number of factors which makes a “non-dependent” procedure (that is, it does not assume that a dependent variable is specified). The data was screened to check for outliers that might attenuate the result following Jirgi (2013).

Specification of factor analysis model

$$Y_1 = \beta_{11}X_1 + \beta_{12}X_2 + \ldots + \beta_{1n}X_n \qquad 3$$

$$Y_2 = \beta_{21}X_1 + \beta_{22}X_2 + \ldots + \beta_{2n}X_n \qquad 4$$

$$Y_3 = \beta_{31}X_1 + \beta_{32}X_2 + \ldots + \beta_{3n}\ X_n \qquad 5$$

$$Y_n = \beta_{n1}X_1 + \beta_{n2}X_2 + \ldots + \beta_{nm}\beta_{nm} \qquad 6$$

Where: $Y_1, Y_2, Y_3, \ldots, Yn$ = observed variables (management strategies),

$B_1, \beta_2, \beta_3, \ldots, \beta n$ correlation co-efficient,

$X_1, X_2, X_3, \ldots, Xn$ = unobserved underlying factors of risk management strategies

Results and Discussion

The result shows that the mean age of the sampled cereal/legume farmers in Niger State was 41 years. This showed that the household heads were mostly youths. This implied that they had a great advantage of practicing new production techniques of the enterprise for a better output. All the sampled farmers for this study were masculine. The result also revealed that 46.8% of the farmers adopted the cropping practice for the past nine years. This implied, that the enterprise worth practicing in the study area. The result further showed that all the farmers were married with a minimum of one dependent.

The vast majority (86.4 per cent) of the cereal/legume farmers in study area were members of at least a cooperative society. This can give them the opportunity of harnessing agricultural input incentives if well managed. In addition, 41.4% had access to credit which was used to finance their cultivation of the cereal/legume enterprise. This implied that less half of the sampled farmers access to credit facility in the study area. The result shows that more than half (59%) of the cereal/legume farmers in the study area had one form of formal education. This implied that there is tendency of comprehending new technologies to improve their productivity.

The risk attitudes of the cereal/legume farmers in Niger State

The result in Table 2 showed that about 59.0% of the cereal/legume farmers were risk averse with negative attitude towards risk. These could be as result of their poor financial status. Thus, they engaged in cultivation primarily to meet their basic needs with little surplus to sell in the market. This corroborates the findings of Sanusi, *et al.* (2021) that 61.1% of the rice farmers in North-central Nigeria operated at poor capital base and lack the mindset of entrepreneurship to commercial production. The Table 2 further showed that 35.6% of the farmers operated at risk neutral status while about 5.4% of the farmers were found to be risk preferring with that took a higher entrepreneurial risk to produce for the market. This could possibly be that they realized the importance of bearing a higher risk and had the financial back-up to behave as risk preferring cereal/legume farmers in the study area.

Table2: Risk attitude of the cereal/legume farmers in Niger State

Risk attitude	Frequency	Percentage
risk averse (< 0)	174	59.0
neutral (0 to <1)	105	35.6
preference (> =1)	16	5.4
Total	295	100.0

Source: Field Survey, 2020

Risks associated with Cereal/Legume enterprises in Niger State

The identified sources of risk challenging the cereal/legume enterprise is presented in table 3. The result shows that about 90.5 per cent of the sampled cereal/legume farmers in Niger State were faced with production risk. The study also finds out that 7.5 per cent of them suffered financial risk. This could be as result of their in ability to fulfil the credit terms. Meaning the respondents were not accessing adequate loan facility to finance their farming activities. Marketing risk constituted 1.4 per cent of total risks associated with the cereal/legume enterprise in the study area.

Table 3: Risk associated with cereal/legume enterprise in Niger State

Type of risk	Frequency	Percentage
Production	267	90.5
Market	4	1.4
Financial	22	7.5
Human	2	.7
Total	295	100.0

Source: Field Survey, 2020

Analysis of risk management strategies of cereal/legume farmers in Niger State

The result in Table 4 showed that spreading sales (0.7410), cooperative society (0.7397), borrowing cash or grain (0.7308), storage programme (0.7169), adashe contribution, (0.7100), training and education (0.6879), gathering market information (0.6781), price support (0.6368), selling before harvest (0.6242) and reduced consumption (0.4975) were the risk management strategies employed by the farmers. This finding is in line with that of Agboola (2015) who reported that selling before harvesting, cooperative society and engagement in off-farm activities were used for aversion of risk among farming households in FCT, Abuja, Nigeria. Family members working off-farm (0.8022), investing off farm (0.6013) and faith in God (0.391) were also used. This implied that involvement in off-farm activities will reduce risk faced by farmers. This corroborates the work of Batool (2017) who stated that diversification into non-farm income served as means of shielding farmers from risk and the uncertainties of agricultural production.

Early planting (0.5034), planting drought tolerant varieties (0.4957), planting early maturing varieties (0.4792) and spraying for disease and pest (0.4303) were the environmental factors adopted for managing risk in the study area. This corroborates Aminu *et al.* (2019) that application of fertilizer, pesticide and insecticide are major ways of reducing risk among farming households in Ogun State of Nigeria.

Table 4: Analysis of risk management strategies of cereal/legume farmers in Niger State

	Niger State		
Variables	Economics/Institutional factor	Off-farm/ spiritual factor	Environmental factors
Selling before harvest	0.6242		
Spreading sale	0.7410		
Training and education	0.6879		
Adashe contribution	0.7100		
Cooperative society	0.7397		
Storage programme	0.7169		
Gathering market information	0.6781		
Price support	0.6368		
Borrowing cash or grain	0.7308		
Reduce consumption	0.4975		
Family members working off farm		0.8022	
Household working off farm		0.6710	

Investing of off farm		0.6013	
Faith in God		0.5391	
Fertilizer provision by self			0.7954
Intercropping			0.6582
Spraying for disease and pest			0.4303
Planting drought tolerant varieties			0.4957
Planting early maturing varieties			0.4792
Early planting			0.5034
Chi2 (χ2)	3571.91	3.62375	2.10208
Eigen-value	6.09841		
% of variance	16.9	31.5	45.5
Kaiser-Meyer-Olkin Test	0.784		
Bartlett's Test of Sphericity (χ2	3559.482		

Sources: Field Survey, 2020

Conclusion

Risk is an essential factor in investment decision making to reduce fundamental problems and encourage agricultural entrepreneurship. Lack of clear understanding of farmers' attitudes towards risks remains an important factor inhibiting increased agricultural productivity. Very few of the cereal/legume farmers were risk preferring in behavior to invest into cereal/legume production at commercial quantity. Spreading sales of farm produce, cooperative membership, borrowing cash/grain, working off-farm, early planting and planting of draught tolerant crops were measures of managing risk associated with the cereal/legume farmers in the study area. The extension agents should put more effort in convincing the farmers that were not members of any cooperative society to do so, to enable them take advantage of the farm input incentives, loans and grants enjoyed by the members of the various cooperative societies.

References

Agboola, O. T. (2015). Analysis of farm risks and management strategies among households in fct, Abuja, Nigeria, Msc Thesis in Department of Agricultural Economics and Rural Sociology, Faculty of Agriculture, Ahmadu Bello University, Zaria, Nigeria. PP1-88.

Aina, O. S. and Omonona, B. T. (2012). Nigeria Agricultural Insurance Scheme (NAIS): Prospect, achievement and problems. *Global Advanced Research Journal of Agricultural Science*, 1(5),97-103.

Aminu, F. O., Balogun, E. O. S. and Oke, O.B. (2019). Farm risks and management strategies among arable crop farmers in Odogbolu Local Government Area of Ogun State, Nigeria, *Agrosearch*, 19(2): 41-53.

Batool, S., Babar, A., Nasir, F. & Iqbal, Z. S. (2017). Income diversification of rural households in Pakistan. *International Journal of Economic and Management Science, 6(6) 466-47.*

Ekere, O. O. & Udoh, J. O. (2014). Multi harzad risk assessment using GIS techniques in the Mboare of Nigeria. *Asian review of Environmental and Earth Sciences*, 1 (1), 1-4.

Jirgi, A. J. (2013). Technical efficiency and risk preferences of cropping systems in Kebbi State, Nigeria. Ph.D Thesis, Department of Natural and Agricultural Economics. University of the Free State, South Africa. 233-234.

Nmadu, J. N. & Peter, J. (2010). Small scale farmers 'willingness to take agricultural insurance in Paikoro Local Government Area of Niger State *Proceedings of the 11th National Conference of the Nigerian Association of Agricultural Economists* held at New Lecture Theatre, School of Agriculture and Agricultural Technology, Federal University of Technology, Minna, Nigeria between 30th November, and 3rd December.

Niger State (GIS, 2020). Background information. Retrieved from www.nigergis.com/about-Niger-State *on 3rd November, 2022.*

Picazo-Tadeo, A. J. & Wall, A. (2011). Production risk, risk aversion and the determination of risk attitudes among Spanish rice producers. *Journal of Agricultural Economics,* 42, 451–464.

Sadiq, M. S., Singh, I. P., Singh, N. K., Lawal, M., Ahmad, m. M., & Eije, O. C. (2018). Application of Safety-first approach to measure risk behaviour of yam farmers in Benue State, Nigeria, *Journal of Scientific Agriculture* 2,52-61.

Sadiq, M.S., Singh, I.P, & Ahmad, M.M. (2021). Productivity Gap by Gender among Rice Farmers in North-Central Nigeria. *Agricultural Socio-Economics Journal* 21(2): 135-148

Tanko, L. & Kpange (2014). Determinant of Sesame productivity in selected Local Government Areas of Niger State, Nigeria. International Research Journal of Agricultural and Aquatic Sciences. 1(1), 001- 008.

22 FUNGI ASSOCIATED WITH MILLET GROWN IN ZONE A AGRO-GEOGRAPHICAL ZONE OF NIGER STATE NORTH CENTRAL NIGERIA

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ABSTARCT
Millet production is affected by fungi which are their significant destroyers from production to storage thereby making them unfit for human consumption by reducing their nutritional composition and some often even produce mycotoxins. The occurrences of these fungi organisms which vary from region to region might be due to climatic differences. Hence, these research looks at possible fungi associated with millet grown in Zone A agro-geographical Zone of Niger State. Millet Samples were collected across nine villages from three selected Local Government Areas (LGAs) located in the zone, associated fungi were isolated from the samples using direct plating on Potato Dextrose Agar adjusted with chloramphenicol as bacteriostatic after which the plates were incubated at 28 ± 2^0 for a period of 5-7 days. Pure isolates of fungi were obtained through sub-culturing. Eight fungi isolates were isolated from the millet grains collected across the zone consisting of four species of Aspergillus, Alternaria spp, Curvularia spp, Fusarium verticilliodes and Mucor spp. A. flavus was observed to have an occurrence rate of 100 % in both Gbako and Lapai LGAs while Mokwa LGA recorded 33. 33 % occurrence rate, Mokwa had 100 % occurrence of Alternaria spp while Gbako and Lapai LGAs recorded 66.67 % and 33.33 % respectively. Mucor spp was recorded only in Lapai LGA at 33.33 %, while both Gbako and Mokwa had no Mucor occurrence. This research thereby serves as a baseline data for fungi organisms found in millet grown in Zone A agro-geographical zone of Niger State, Nigeria.
Keywords: Aspergillus spp, Fungi, Millet, Zone A, Niger State,

Introduction

Millets and their derivatives are important nutrient sources for mankind world-wide, they are one of the most important forms of dietary food for most of Africans populations (Riba *et al*., 2014), and also major source of calories and proteins for the people of Nigeria especially the Northern part (Sultan *et al*., 2022). It is one of the major cereal crop cultivated in Nigeria amongst sorghum, rice and maize. Ogi (the fermented cereal porridge) commonly called akamu in Northern Nigeria and Niger State inclusive is the major product of millet which is consumed mainly as breakfast with some other delicacies like akara (bean cake), kuli-kuli (groundnut cake) and many others, The production of millet is mostly concentrated in the drier parts of the region owing to its drought tolerance (FAO, 2002).

Fungi Mycro-flora are significant destroyers of grains especially millet from production to storage thereby making them unfit for human consumption by reducing their nutritional composition and some often even produce mycotoxins. Pandey and Trivedi, (2008) have in the past submitted various reports showing yield losses of up to 67% resulting from fungi damaging grains in several ways; they reduce the germinability, produce undesirable odour and kernel discolouration, depletion in seeds viability, hardness, colour, size and shape, grain weight and various biochemical parameters; protein, carbohydrate and vitamins decrease the food value and can also lead to production of toxins injurious to human health (Matthew *et al*., 2010).

Niger State is one of the major producers and consumers of millet crop. The State which is the

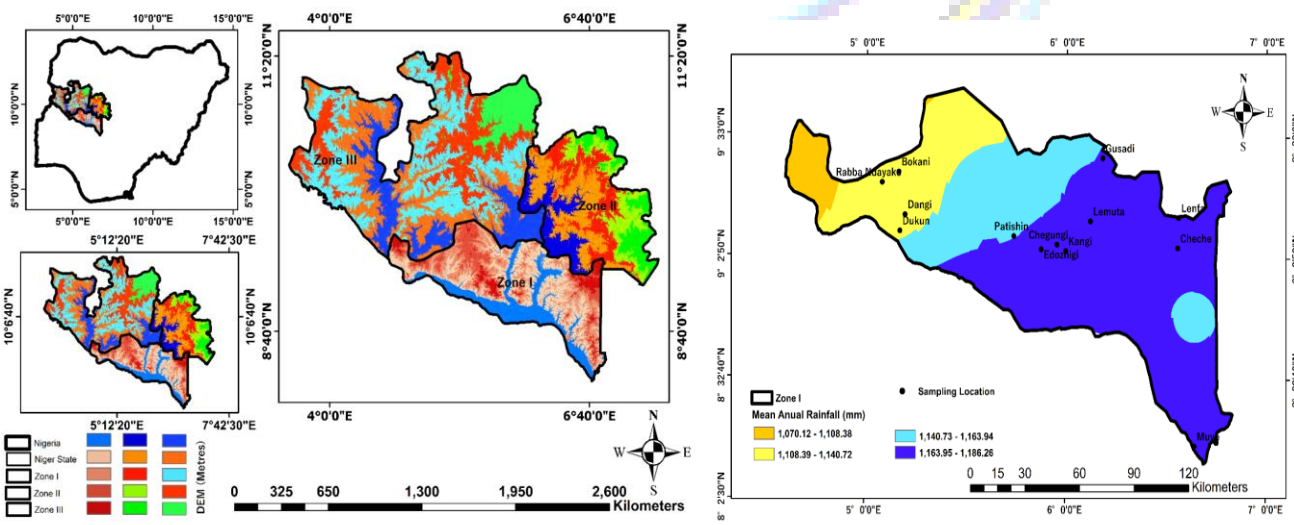
Largest in land mass in Nigeria comprises of twenty-five local government area which is divided into three agro-geographical zones base on rainfall (Zone A, Zone B, Zone C). The Zone A which is the Southern region of the state consists of eight LGAs (Agaie, Bida, Edati, Gbako, Katcha, Lavun and Mokwa), the Zone B the Eastern part has nine LGAs (Agwara, Borgu, Magama, Mashegu, Mariga, Kontagora, Rijau and Wushishi) and the Zone C the Northern part which has eight LGAs (Bosso, Chanchaga, Gurara, Munya, Paikoro, Shiroro, Suljeja and Rafi) Yatswako and Alhaji, (2017). This research was designed to study the occurrence of fungi associated with Millets grown in the Zone A agro-geographical Zone selecting three LGAs (Gbako, Lapai and Mokwa).

Materials and Methods

Millet samples (1kg) were collected from three villages from the three selected LGAs in Zone A agro-geographical zone of Niger State, Nigeria. The Local Governments includes Gbako (Edozhigi, Gusadi and Lemuta), Lapai (Cheche, Lenfa and Muye) and Mokwa (Bokani, Dukun and Rabba) in sterile polythene bags and were transported to the microbiological lab Step-B Federal University of Technology for fungi isolation and identification. The Maps below gives an insight of the sample sights and the rainfall activities of the year 2021 in which the research was carried out. The samples were collected between the months of November and December harvesting season of the year 2021 from farmers across the selected LGAs.

Isolation of Fungi from Millet Samples

Fungi were isolated from the samples using direct plating method where the millet samples collected were washed with tap water and disinfected with sodium hypochlorite (0.5 %) for 2 minutes, then rinsed thoroughly with sterile distilled water to remove the remaining sodium hypochlorite, and later dried with whatman No. 1 filter paper to remove excess moisture (Abdullahi *et al*., 2018). The washed and dried samples (10 grains) were then evenly plated on petri-dishes containing Potato Dextrose Agar which was adjusted with chloramphenicle to outdo the growth of bacteria organisms, the plates were then incubated at 28 ± 2^0 for a period of 7 days for eventual growth of fungi (Abdel-Hafez et al., 2017), and for each of the samples three replicates were maintained.



Identification and Characterization of Fungal Associated with Millets

Colony appearance of fungi on each plate were counted and recorded while pure isolates of the fungi were obtained through sub-culturing. The frequency of occurrence (%) was calculated using the formula described by Bamkifa *et al*., (2019) with little modifications.

$$\text{Frequency of occurrence (\%)} = \frac{\text{the presence of an isolate in the village}}{\text{Total number of villages}} \times 100$$

Microscopy

Wet mount method of slide preparation was used to prepare the slides for microscopy, a thin slice of the various pure culture were separately cut and placed on a clean dry slides using a sterile needle, a drop of water was added to the samples on the slides using a dropper and were cover with coverslip at a 45-degree angle with one edge touching the water and let go to evenly spread the sample which were held in place by surface tension avoiding air bubbles. The slides were then placed under the microscope with a magnification power of X4 where the morphological characters of each of the isolates were viewed and photomicrographed to be compared with those described by standards manual of fungi identification by Barnett and Hunter, (2003).

Data analysis

The data obtained from the experiment were analyzed using Microsoft excel sheet where two-way Analysis of Variance (ANOVA) was conducted to check where there are differences between the three LGA sampling sites (Gbako, Mokwa and Lapai) on the various fungal isolates at 5 % Level of significance.

Results and Discussion

Eight different fungi isolates comprising of four *Aspergillus species* (*A. flavus*, *A. niger*, *A. fumigatus* and *A. terreus*), *Alternaria spp*, *Curvularia spp*, *Fusarium verticilliodes* and *Mucor spp* were isolated from the millet samples collected across the Zone A agro-ecological zone of Niger State and are shown in table 1 below.

In Gbako and Lapai LGAs *Aspergillus flavus* had 100 % occurrence while it's occurred in Mokwa at 33.33 %, *A. niger* occurred at 33.33 % in Gbako and Lapai wahile its had a higher occurrence rate in Mokwa to be 66. 67 %. *Alternaria spp* occurred at 100 % in Mokwa while its occurrence rate was at 66. 67 % and 33.33 % for Gbako and Lapai respectively. *Curvularia spp* and *Fusarium spp* both had an occurrence rate of 33. 33 % in both Gbako and Mokwa LGAs and they both occurred in Lapai LGA at 66. 67 % and shown in Table 2 which is as well illustrated in the graph shown.

These results are similar to the reports of Sultan *et al*., (2022) who reported the presence of six fungi isolates (*A. flavus*, *A. niger*, *Alternaria*, *Cladosporium*, *Fusarium* and *Rhizospus*) from Maize, Millet and sorghum collected from two Markets in Kano State, Nigeria, Makun *et al*., (2007) also reported the presence of 5 species of *Aspergillus*, 3 species of *Fusarium*, 1 species of *Helminthosporium, Penicillium, Penicillium, Phoma, Mucor, Rhizopus, and Syncephalastrum spp*.

The cultural characteristics of *Alternaria spp* grew rapidly with a colony size reaching a diameter to 3- 9 cm following 7 days incubation period at 25-28 $^0 \pm 2\,^o$ C on PDA, it had a flat colony with short aerial hyphae with initial greyish white at the beginning of the growth that later turned greyish black or with a light border and the reverse side is typically brown to black. The microscopic view shows septation with brown hypae, they had also brown septated conidiophores which are arranged in a zigzag form (Plate I **A** and **B)** this corresponds with what is obtainable the book of Larone (1995). The *Curvularia spp* cultural features ranges from rapid growth colony with a whitish to pinkish grey which later turns to brown or black as its grows older and the reverse side is usually dark brown to black. The microscopic image of *Curvularia spp* similarly revealed a brown hyphae, brown conidiophores that are simple, branched, or bent at the origin of the conidia. The central cell looked typically darker and enlarged as compared to the end cells in the conidium and there is a visible swell in the central cell which gives the conidium a curved shape (Plate I **C** Aand **D**), this is however related to the features explained by De Hoog *et al*., (2000).

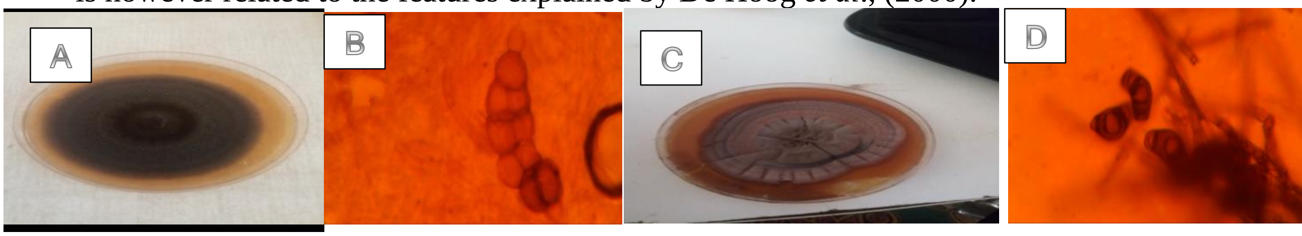


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Plate I: A shows the cultural character, **B** shows the photomicrograph of *Alternaria spp***, C** shows the cultural character, **D** shows the photomicrograph of *Curvularia spp*.

Table 1: Showing the presence and absence of fungi isolates in the three LGAs with each of the villages, + presence of isolate, - absence of isolate.

S/no.	Name of Isolates	Local Government Areas and Villages								
		Gbako			Lapai			Mokwa		
		Edozhigi	Gusadi	Lemuta	Cheche	Lenfa	Muye	Bokani	Dukun	Rabba
1	*A. flavus*	+	+	+	+	+	+	-	-	+
2	*A. niger*	-	+	-	-	-	+	+	+	+
3	*A. fumigatus*	+	+	-	+	+	+	+	+	-
4	*A. terreus*	-	-	-	-	-	-	-	-	-
5	*Alternaria spp*	+	-	+	-	+	-	+	+	+
6	*Curvularia spp*	+	-	-	-	+	+	-	+	-
7	*Fusarium verticillioides*	+	-	-	-	+	+	+	-	-
8	*Mucor spp*	-	-	-	+	-	-	-	-	-

Generally, *Aspergillus flavus* had the highest frequency of occurrence to be 77.78 % in all the LGAs with Mucor having the least occurrence rate which was 11.11 %, as shown in table 3, this is in line with the work of Bamkefa *et al*., (2019) who reported the occurrence of *Mucor spp* to be 2.4 % as compared to the 25 % occurrence rate of *A. fumigatus*,. Similarly, Hadiza *et al*., (2019) also reported the highest occurrence rate of fungi isolated from Maize in Niger State to be *A. niger* at 75 %, followed by *A. flavus* with 68 % and the least was at 12 % for the fungi *Penicillium sp* and according to the Food and Agriculture Organization (FAO), 25% of the World food crops, including many basic foods are affected by mycotoxin producing fungi (Köppen *et al*., 2010).

Table 2/Graph: Showing Isolates and their % occurrence in each of the LGAs

Isolates	LGAs		
	Gbako Lapai	Mokwa	
A. flavus	100	33.33	100
A. niger	33.33	66.67	33.33
A. fumigatus	66.67	33.33	100
A. terreus	33.33	66.67	33.33
Alternaria spp	66.67	100	33.33
Curvularia spp	33.33	33.33	66.67
Fusarium Verticilloides	33.33	33.33	66.67
Mucor spp	0	0	33.33

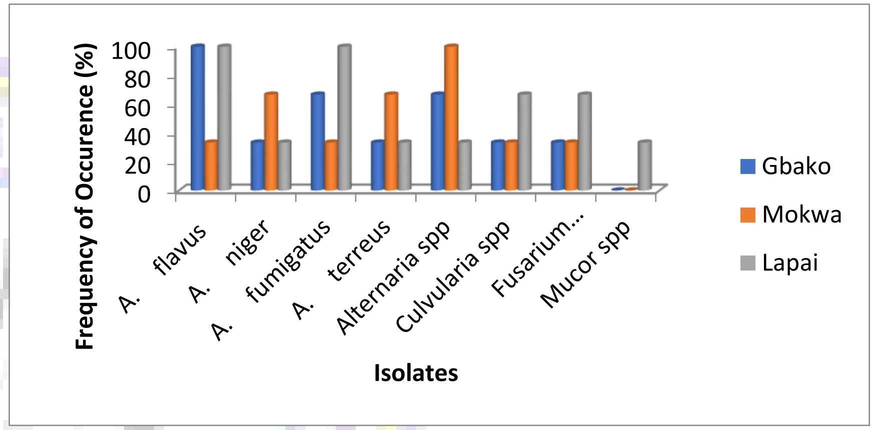

Table 3: General frequency of occurrence of isolates in the study LGAs.

	Gbako	Mokwa	Lapai	Total	Frequency of Occurrence (%)
A. flavus	3	1	3	7	77.77778
A. niger	1	2	1	4	44.44444
A. fumigatus	2	1	3	6	66.66667
A. terreus	1	2	1	4	44.44444
Alternaria spp	2	3	1	6	66.66667
Curvularia spp	1	1	2	4	44.44444
Fusarium Verticilloides	1	1	2	4	44.44444
Mucor spp	0	0	1	1	11.11111

Conclusion

Rainfall could be a great determinant of the presence of fungi organisms in a particular environment as it's determines the moisture content and temperature conditions of crops, (in this regard Millet) in which organisms could thrive. This factor ranges from region to region and hence could be what influenced the presence or absence of fungi organisms in Zone A agro-geographical Zone of Niger State, Nigeria as compared to other regions of the state and similarly other parts of the Country at large.

References

Abdel-Hafez, S. I. I., Abdul-Sater, A. M. Hussein, A-G. N. & Amery, A-W. E.(2017). Fungal diversity associated with pearl millet *Pennisetum glaucum* l.) grains from taiz governorate, yemen and their amylase production. *Journal of Microbiology, Biotechnology and Food Sciences*, 7(2),118-123.

Abdullahi, K. K., Adebola, M. O. & Ajayi, H. O. (2018). Antifungal efficacy of three plant extracts in the suppression of panama disease in banana plants. *GSC Biological and Pharmaceutical Sciences*, 05(01), 095–103.

Bamkefa, B. A., Uwaga, I., Akintobi, O. A., Adejuwon, A. O., Umezurike, E. T., Balogun, O. and Obayemi, O. S. (2019). Mycoflora Associated with Millet (*Pennisetum glaucum* L.) Purchased from Major Markets in Ibadan Metropolis, Nigeria. *Advances in Bioscience and Bioengineering*, 8, 2020, 1.

Barnett, H.L. and Hunter, B.B. (2003). Illustrated genera of imperfect fungi. University Missouri Press,Columbia.

De Hoog, G. S., Guarro, J., Gene, J. & Figueras, M. J. (200). Atlas of Clinical Fungi, 2nd Edition, Volume 1. Centraalbureau voor Schimmelcultures, Utrecht, The Netherlands.

Food and Agricultural Organisation FAO. (2002). Data base, Food and Agricultural Oganisation, Roma, Italy.

Hadiza, K. M., Daniel, O. A., Hadiza, L. M., Yemisi, B. O., Ebere, I. & Hussaini, A. M. (2019). Mycoflora of Maize in Niger State, Nigeria. A*dvanced Research in Life Sciences,* 3 (1), 40-45.

Köppen, R., Koch, M., Siegel, D., Merkel, S., Maul, R., & Nehls, I., (2010). Determination of mycotoxins in foods: current state of analytical methods and limitations. *Applied Microbiology and Biotechnology*, 86, 1595e1612.

Larone, D. H. (1995). Medically Important Fungi- A Guide to Identification, 3rd Edition. ASM Press, Washinton, D. C.

Makun, H. A., Gbodi, T. A., Tijani, A. S., Abai, A. and Kadiri, G. U. Toxicologic screening of fungi isolated from millet (*pennisetum spp*) during the rainy and dry harmattan seasons in Niger state, Nigeria (2007). *African Journal of Biotechnology,* 6 (1), pp. 034-040.

Mathew, S., Thomas, G. & Ahmed, T. (2010). An evaluation on the Impact of Fungi on the Post-Harvested Stored Wheat Grains. *International Journals of Biotechnology and Biochemistry*, 6: 9951002.

Pandey, S. N. & Trivedi, P. S. (2008). A textbook of Botany Volume I, Vikas publishing house PVT limited, India.

Riba, A., Bouras, N., Mokrane, S., Mathieu, F., Lebrihi, A. & Sabaou, N. (2010). *Aspergillus* section Flavi and aflatoxins in Algerian wheat and derived products. *Food and Chemical Toxicology*, 48, 2772-2777.

Sultan Z., Nuhu, A. A., Aminu, I. M., Kamal, A. A. and Sumayya, S.S. (2022). Isolation and Molecular Identification of Fungi Associated with Stored Grains Sold at Dawanau and Rimi Markets of Kano State, Nigeria. *Acta Scientific Agriculture,* 6 (6): 39-48.

Yatswako, S. & Alhaji, N. B. (2017). Survey of fasciolosis burdens in trade cattle slaughtered at abattoirs in North Central Nigeria: The associated predisposing factors and economic implication. *Parasite Epidermiology and Control.* 22, 2 (2): 30-39.

23 GENDER ANALYSIS OF FARMING HOUSEHOLDS' ACCESS TO LIVELIHOOD RESOURCES IN SELECTED LOCAL GOVERNMENT AREAS OF NIGER STATE, NIGERIA

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ABSTRACT
The study analyzed rural farming households' access to livelihood resources along gender line in Bosso, Chanchaga and Wushishi Local Government Areas of Niger state, Nigeria. The specific objectives of the study were to: describe the socio-economic characteristics of the rural farming household along the gender line; examine their access to livelihood resources; determine the factors influencing access to livelihood resources along the gender line and examine the constraints associated with accessing livelihood resources. Three-stage sampling procedure was used to select 130 rural farming household heads (67 male and 63 female). Semi-structured questionnaire complemented with an interview schedule was used to obtain primary data which was analyzed using descriptive statistics and Probit regression model. The results revealed that majority (71.7%) of the male were between 41-50 years of age with a mean of 46 years, while 47.6% of the female were in the age range of 41-50 years with a mean of 44 years. More so, 71.6% and 63.5% of the male and female farming households respectively, had household size of 1-5 people with mean of 6 persons. Majority (82.1%) of the male farming households had access to farmlands, while most (68.7%) of the female had no access to farmlands. Also, more than half (56.7%) of the male had access to communication facilities while 55.6% of the female had no access. Probit regression analysis revealed age of the male (0.0466; $P<0.05$), cooperative membership (1.6684; $P<0.01$) and annual income (-2.83e-06; $P<0.10$) to be positive and significant. In the same vein, age of the female (0.1429; $P<0.01$), cooperative membership (1.8387; $P<0.05$) and annual income (5.55e-06; $P<0.10$) were positive and significant, while marital status (-0.4836; $P<0.05$) was negative and significant. Poor credit and unfavorable government policy were the most serious constraints faced by the rural farming households along gender line in the study area. The study recommended that government and other relevant stakeholders should provide the rural households with credit at subsidized rate to enable them enhance their livelihood. Also, favorable government policy should be put in place that can improve livelihood of the rural households in the study area.
Keywords: Gender, rural household, livelihood, resources, access

INTRODUCTION
Agriculture plays a pivotal role in the provision of employment opportunities and income to most rural inhabitants in developing nations, Nigeria inclusive. However, many of the rural farming communities continue to produce at subsistence level using crude implements which result in low output, thus, making farming less productive, less profitable and unattractive endeavour. This might not be unconnected to their inability to access livelihood resources. Livelihood could be described as the way people combine and use their assets, capabilities and undertake activities to

secure a means of living (Micheal *et al.,* 2021). The various activities undertaken by people in order to earn income help to reduce Vulnerability and increase their overall living standard within the subsiding social, economic, political and environmental influence on livelihood strategies (Eneyew and Bekele, 2012).

Nwandu *et al.* (2016) averred that, the choice of livelihood activities depend largely on access to and control over five major livelihood assets/capitals which include; human, Physical, social, financial and natural capitals. However, poor households face livelihood problems such as exposure to risks, malnutrition, shorter life expectancy and inadequate access to social and economic services as well as limited opportunities for income. It is a fact that, both men and Women do not have the same access to livelihood resources, despite the equal roles they play in agricultural production activities. FAO (2009) posits that rural women do not have equal access and control over assets as men, particularly land and fund, reducing their socioeconomic well-being. Oyesola and Ademola (2012) stressed that rural women lack access to social assets such as networks and associations which mar their ability in political decision making. Furthermore, female face inequalities in accessing education, skill development and training opportunities, particularly in the northern part of the country attributable to religious and cultural beliefs and this impede their capabilities. These therefore call for strategies that can help in reducing gender inequalities in accessing livelihood resources as this will not only improve nutrition, health and education outcomes, but it will help in the realization of both immediate and long-time economic and social benefits for families, communities and the nation as a whole (Aliyu *et al.,* 2021). The study was therefore conceived, to extend the frontier of knowledge of farming households' access to livelihood resources along gender line as well as factors influencing their access to such resources in the study area.

METHODOLOGY

The study was carried out in Bosso, Chanchaga and Wushishi Local Government Areas of Niger State, Nigeria. Niger State lies between Latitude 8°20' and 11°30' North, and Longitude 3°30' and 7°40' East of the equator. The state covers an estimated land area of 74, 244 KM² with a human population of 3,954,772 people (NPC, 2006). However, the population was projected in 2019 using 3.2% growth rate of National Burenau of Statistics (NBS) to be 5,960,112 people. The state experiences two distinct seasons namely; wet and dry, with annual rainfall varying from 1100mm-1600mm. The temperature ranges from 23°C-37°C (Niger state Agricultural and Mechanization Authority (NAMDA, 2018). The major occupation of the people is farming (Crop and livestock). Three-stage sampling procedure was used. First stage involved purposive selection of three Local Government areas (LGAs) due to their predominant livelihood activities along gender line. Second stage was random selection of two villages from each of the selected LGAs which produced six villages. The third stage involved random selection of 130 respondents (67male and 63 female). Primary data were collected using semi-structured questionnaire complemented with interview schedule. Data were analyzed using descriptive (frequency counts, percentage and mean) and inferential (probit regression model) statistics.

RESULTS AND DISCUSSION

Socio-economic characteristics of the respondents

The socioeconomic characteristics of the rural farming household, described along gender line are presented in Table 1. Majority (71.6%) of the male headed households were in age bracket of 41-50 years with a mean of 46 people while 47.6% were female headed who aged between 41-50 years with a mean of 44-years. This implies that most of the household heads in the study area were in their active productive age, capable of undertaking livelihood activities. This finding disagree with that of Obi-Egbodi *et al.* (2021) who in their study area (Ogun State) found female household heads to be above their active productive age. This may have negative implication on their access to livelihood resources. Tables1 also shows most of the household heads to be married with household size of 6 persons on the average. More so, about 35.8% of the men and 47.6% of the women had no education. Although, a greater proportion of the male possess one form of education or the other. This was expected to be an advantage for the male over the female in accessing livelihood resources.

Gender Access to Livelihood Recourses

The results in Table 2 revealed that Majority (82.17%) of the male had access to farmland as against 31.3% of the female who had access to farmland. This implies that greater proportion of men had access to farmland in the study area. This finding substantiates that of Adebola *et al.* (2015) who noted that historically, in most cultures, female access to land involved right of use, but not ownership and that when common land is converted into state ownership and then to private land, women often lose their traditional right and are not always considered when new laws are enacted. Results further revealed that (Table 2) greater proportion of both male (64.2%) and female (57.1%) had no access to improved technology. This implies that rural farming households in the study area had poor access to improved technology and this was likely to impact negatively on their well-being. Also more than half (56.7%) of the male had access to communication facilities as against 44.4% of the female rural farming households. This may be attributed to better literacy attainment by the male. Literacy level assist individual to understand the benefit and how to use communication facilities. Group membership was high for both gender, about 79.1% of the male and 88.9 % of the female were members of social group. This implies that rural greater proportion of the rural farming households in the study area were members of one group or to order. This might be attributed to their understanding of benefit derivable in group membership, as most the government or international donor assistance to rural farming households are targeted at group rather than individuals.

Also, majority (62.7%) of the male were involved in decision making as against 49.2% of the female. This implies that, in decision making male have better opportunity to partake in decision making than female, this scenario can be attributed a typical aspect of gender inequality. This finding concurs with that of Adebola *et al.* (2015) who reported that, low participation in decision making by female to be a typical aspect of gender inequality. The result further indicated gender, (male 61.8% and female 57.1%) respectively had poor access to financial resources. Also in terms of government support fund like giants just a few of both gender (male 25.4% and female 30.2%) had access to such livelihood resources. This implies that majority of the rural farming households were poorly assisted and this was likely to impact negatively on their well-being. More so, more than half (53.7%) of the male had access to quality education as against 47.6% of the female, implying that greater proportion of the male had better access to quality education. Table 2 showed both gender (male 83. 6% and female 66. 7%) had access to rural labour as against just a few women (17.5%) that had access to labour. This implies that just a small proportion of the female can access rural labour, this may be due to their limited financial resources and marginalization by the male. Similarly, most(56.7%) of the male had access to skill acquisition while about 44.4% of the female had access, implying that the female rarely have equal opportunities with male in participating in skill acquisition which can enhance their livelihood activities.

Factors influencing Rural Household Access to Livelihood Resources

Table 3 revealed the result of probit model used in analyzing the factors influencing rural farming households' access to livelihood resources. Age is positive and significantly influence male access to livelihood resource (P<0.05), age of the female is positive (0.145299) and significant (p<0.01). This implies that as the respondents along gender line in the study area advances in age they were more likely to access livelihood resources. The marital status of the female is negative (-0. 4835588) and significantly influenced access to livelihood (p<0.01), implying female that were unmarried have less chances to access livelihood resources. Coop. membership of the male was positive (1.668409) and significantly influenced their access to livelihood resources (p<0.001) also female coop. membership had positive coefficient (1.838672) and significantly influenced their access to livelihood resources (p<0.10). This result revealed male that were members of coop. societies were more likely to access livelihood resources more than the female. This might be due to disparity in recognition female always experience in the society.

The result further indicated that, total annual income of male had positive coefficient (2.83E-06) and significantly influenced their access to livelihood resources (P<0.10). Also, the coefficient of total annual income of the female had positive coefficient (5.55-06) and significantly influenced their access to livelihood resources (P<0.05). This implies that, the more total annual income of the respondents, the more likelihood to access livelihood resources as it is believed that individuals with good Socio economic disposition were more likely to pay for whatever assistance they have received in form of loan. More so, number of cooperative membership had positive coefficient (0.538755) and significantly influenced female access to livelihood resources (P<0.10). This implies that, the number cooperate societies female belong the more likely to access livelihood resources.

Constraints faced by Rural farming households in Accessing Livelihood Resources

Table 4 revealed some major constraints faced lay the male to include poor credit facilities ($\dot{x}$=2.30), unfavorable government policy ($\dot{x}$=2.26), lack of basic infrastructure ($\dot{x}$=2.24), poor transportation and inadequate farmland ($\dot{x}$=2.22), and high level of illiteracy. Similarly, some of the constraints considered by the females as very serious are; poor credit ($\dot{x}$=2.95), unfavorable government policy ($\dot{x}$=2.56), lack of basic infrastructure ($\dot{x}$=2.52), poor transportation ($\dot{x}$=2.38) and poor storage facilities ($\dot{x}$=2.22).

CONCLUSION AND RECOMMENDATIONS

The study concluded that most of the rural farming households along the gender line in the study area faced problem of poor access to credit facilities as well as unfavorable government policies on livelihood resources. It was therefore recommended that, government and well to do individuals should assist rural farming households in the study area with subsidized credit facilities to enable them increase production. Also government should always formulate policies that favour rural farming households in their bid to access livelihood resources.

REFERENCES

Adebola, A. A., Oladimeji, I. O., Koichi, I. & Tadasu, T. (2015). Rural women farmers' access to productive resources: the moderating effect of culture among Nupe and Yoruba in Nigeria. *Journal of Agriculture and Food Security*, 4 (26), 2–9.

Aliyu, M. K., Ibrahim, A. L., Umar, H. S., Umar, A. M., Muhammad, K., Lawal, A., Olanipekun, O. A. & Qasim, O. H. (2021). Gender Accessibility to Agriculture Produce Resources among

Rural Farmers in North-Eastern Nigeria. A Proceeding of the 26th Annual Conference of Agriculture Extension Society of Nigeria (AESON) held at Federal University of Agriculture, Abeokuta, Nigeria from 26th – 29th April, pp 108–119.

Eneyew, A. & Bekele, W. (2012). Department of Livelihood Strategies in Wolaita, Southern Ethiopia. *Agricultural Research and Reviews*, 1 (5), 153–161.

Food and Agriculture Organisation (FAO) (2009). Women and rural employment. Economic and Social Perspective Policy Brief 5, 153–154.

Micheal, A., Tashikalma, A. K., Kolawole, A. A. & Akintunde, A. O. (2021). Rural livelihood improvement: An assessment of household strategies and activities in Adamawa State, Nigeria. *Journal of Rural and Community Development*, 16 (1), 1–22.

Nwandu, P. I., Ojogbane, J. A. & Okechukwu, F. (2016). Poultry production business: A means of alternative poverty among farmer. *International Journal of Innovative Agriculture and Biology Research*, 4 (2), 21–30.

Nation population commission (NPC) (2006). National population census, Federal Republic of Nigeria Official gazelle, Lagos, Nigeria.

Niger state Agricultural and Mechanization Development Authority (NAMDA) (2018). Prospect of Niger State Agricultural and Mechanization Development Authority (NAMDA), Minna, Niger State, pp 18–20.

Obi-Egbedi, O., Omotoso, O. S. & Ajayi, O. I. (2021). Livelihood diversification gender and poverty among rural household in Osun State, Nigeria. *Journal of Rural Economic and Development*, 23 (1), 34–41.

Oyesola, O. & Ademola, A. O. (2012). Gender analysis of Livelihood Status among dwellers of Ileogbo Community in Aiyechie Local Government Area of Osun State, Nigeria. *American Journal of Human Ecology*, 1 (1), 23–27.

Table 1: Socio-economic characteristics of the respondents

Variable	Male (n = 63)		Female (n = 63)	
	Frequency	Percentage (%)	Frequency	Percentage (%)
Age (Years)				
30-40	10	14.9	18	28.6
41-50	48	71.6	30	47.6
51-60	4	6.0	14	22.2
Above 60	5	7.5	1	1.6
Mean	46		44	
Marital status				
Married	48	71.6	40	63.5
Divorce	6	9.0	7	11.1
Widow	9	13.4	10	15.9
Single	4	6.0	6	9.5
Household size (No)				
1-5	42	62.7	45	71.4
6-10	18	26.9	15	23.8
Above 10	7	10.4	3	4.8
Mean	6		6	
Level of education				
Non formal	24	35.8	30	47.6
Primary	20	29.9	21	33.4
Secondary	14	20.9	8	12.7
Tertiary	9	13.4	4	6.3

Source: Field Survey, 2021

Table 2: Rural households' access to various resources

Livelihood	Male (n = 63)		Female (n = 63)	
	Frequency	Percentage (%)	Frequency	Percentage (%)
Physical resources -bold				
Access to farmland	55	82.1	20	31.3
Access to important technology	24	35.8	27	42.9
Access to communication faculties	38	56.7	28	44.4
Group membership	53	79.1	56	88.9
Participation in decision making	25	62.7	31	49.2
Financial resources-sold				
Access to credit facilities	26	38.8	27	42.9
Access to government support fumd (grants)	17	25.4	19	30.2
Human resources-bold				
Access to quality education	36	53.7	30	47.6
Access to good health service	56	83.6	42	66.7
Access to rural labour	48	71.6	52	17.5
Access to skills acquisition	38	56.7	35	44.4

Source: Field Survey, 2021

Table 3: Factors influencing rural household's access to livelihood resources

Variables	Male (n = 63)		Female (n = 63)	
	Coefficient	t-value	Coefficient	t-value
Age	0.0465909	1.91**	0.145299	2.45***
Marital status	0.0766397	1.29	-0.4835588	-3.14***
Household size	-0.0246522	-0.27	0.0116074	0.04
Education level	1.867527	1.56	1.096088	0.39
Occupation	-0.4770486	-1.14	0.6114843	-0.73
Extension contact	-0.4770486	-0.04	0.4257184	0.73
Cooperative membership	1.668409	3.53***	1.838672	1.66*
Access to credit	-0.6108885	-1.27	-0.3582717	-0.78
Annual income	2.83E-06	1.79*	5.55E-66	2.40**
Income savings	0.090145	0.21	0.2878936	0.65
Number of cooperatives	-0.0483143	0.54	0.538755	1.81*
Constant	-4.929692	-2.84***	-6.439628	-1.69*
Chi-Squared		24.26		32.27
Pro>chi^2		0.0143***		0.00134***
Psendo R^2		0.2612		0.3778

Source: Field Survey, 2021

Note: ***, ** and * implies significant at 1%, 5% and 10% level of probability

Table 4: Constraints faced by rural household access to livelihood resources

Constraints	VS (%)	S (%)	NS (%)	WM (ẋ)	Decision
Male					
Poor credit facilities	27 (40.3)	33(49.3)	7(10.4)	2.30	Serious
Unfavorable Government policy	26 (38.8)	32(47.8)	99(13.4)	2.25	Serious
Lack of infrastructure	24 (35.8)	35(52.2)	8(11.9)	2.25	Serious
Poor transportation system	29 (43.3)	32(35.8)	14(20.9)	2.22	Serious
Inadequate farm land	25 (37)	32(47.8)	10(14.9)	2.22	Serious
Community culture, value and norms	16 (23.9)	33(46.3)	18(26)	1.97	Not Serious
High level of illiteracy	22 (32.8)	31(46.3)	14(20.9)	2.12	Serious
Poor storage facilities	6 (9.0)	25(37.3)	36(53.7)	1.55	Not Serious
Female					
Poor credit facilities	30 (47.6)	23(36.5)	10(15.9)	2.95	Serious
Unfavorable Government policy	41 (65.1)	16(25.4)	6(9.5)	2.56	Serious
Lack of infrastructure	37 (58.7)	22(34.9)	4(6.4)	2.52	Serious
Poor transportation system	31 (49.2)	25(39.7)	7(19)	2.38	Serious
Inadequate farm land	23 (36.5)	20(31.7)	13(20.6)	2.16	Serious
Community culture, value and norms	19 (30.2)	20(31.7)	24(38.1)	1.92	Not Serious
High level of illiteracy	10 (15.9)	35(55.6)	18(28.6)	1.87	Not Serious
Poor storage facilities	21 (33.3)	35(55.6)	7(11.1)	2.22	Serious

Source: Field Survey, 2021

Note: VS = Very Serious, S = Serious, NS = Not Serious and WM = Weighted Mean

24 FARMERS' PERCEPTION OF EFFECTIVENESS OF EXTENSION AGENTS IN OSUN STATE, NIGERIA

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Abstract

The study assessed the farmers' perception of the extension agents' effectiveness in Osun State, Nigeria. Multistage sampling procedure was used to elicit information from 240 farmers. Data were analysed using descriptive statistic such as frequency counts, mean and percentage. The result reveals that 57.25 percent of the respondents were male with their mean age and household size estimated at 47 years and 7persons respectively. This showed that majority of the respondents were still in their economic productive age with mean income from farming estimated at ₦49,500.50. Distribution of respondents based on perceived assessment of extension agents' (EAs) knowledge/mastery of subject matter revealed that 32.50 percent, 21.67 percent and 55.0 percent of the respondents perceived EAs as low in term of benefits from the messages, moderate in term of integrate theories with practical and high in term of topics presentation, respectively. The distributions of the respondents based on their perception about EAs mastery of subject matters relating to agricultural practices, showed that 67.50 percent of them were in the opinion that EAs are knowledgeable in technological application in crop production. In addition, 51.67 percent of the EAs are knowledgeable in processing/storage technology, 37.50 percent were into input distribution, 32.50 percent in income generating strategies and 41.67 percent in marketing strategies. The research therefore recommends training and revalidating should be organized to extension agent to boost their knowledge on subject matter.

Keywords*:* Extension agents, Subject matter, Marketing, Respondents, Technology dissemination

Introduction

Over the years, agricultural extension has been at the forefront in delivery of adequate information for farmers for increased production (Ezeh, 2013). The role of extension today goes beyond technology transfer but includes assisting farmer to form groups, dealing with marketing issues, addressing public interest issues in rural areas such as resource conservation, agricultural production, food safety, nutrition, family education, and youth development (Ijeoma and Adesope, 2015). Various agricultural extension approaches have been employed to deliver extension services to farmers in the world (Ibitoye, 2013). Such extension approaches include general ministry-based extension services; integrated extension; university-based extension; commodity-based extension; input supply extension; participatory extension; and farming systems research and extension (Ibitoye, 2013). Some extension approaches were successful than others, but none of them were exceptionally good in reaching and involving the majority of poor farmers. Ezeh (2013) observed that agricultural extension depends largely on information exchange between farmers and broad range of other actors that directly link agricultural knowledge and information.

Ijeoma and Adesope (2015) opined that the mission of the extension service is to provide research-based information, educational programs, and technology transfer and needs of the people, enabling them to make informed decisions about their economic, social and cultural well-being.

Problem Statement

Traditional farming is the most predominant practice adopted by many farmers in Nigeria, which usually resulted in declining in agricultural production yearly (Codjoe *et al.*, 2013). The blame on the observed decline in agricultural production was due to dependency of farmers on traditional agricultural technologies and inadequate innovation (Agbamu, 2007). Based on this, a wide range of policies, strategies, and approaches were formulated by the Nigeria government to reverse the worsening food and agricultural trends towards sustaining agricultural growth. These included, introducing a range of agricultural initiatives and the Agricultural Development Project (ADP). Despite all these efforts, farmers seem to have not benefited from agricultural sector initiatives especially food crop farmers in Osun state in particular have failed to benefit from services delivered by agricultural extension agents under the introduced initiatives (Apantaku and Oyegunle, 2016). According to Gwary *et al. (*2013), food crop farmers in rural areas have been experiencing low yields, which were attributed to lack of extension services and poor technical knowledge. As a result, the general extension approaches was seen as being ineffective in enhancing farmers' adoption of innovations. Therefore, the interaction between the extension agents and the farmers and the extent to which farmers perceived extension agents as useful to them is vital to bringing change in agricultural output and could explain the dynamics embedded in advices adopted by farmers in a given locale (Ibitoye, 2013). For example, the frequency of contact by extension agents is crucial because it is through this that important and useful information about improved and recommended agricultural practices are disseminated to farmers (Iwena, 2008). The amount or type of useful information disseminated to farmers will be useful to determine the effectiveness of extension agents in transferring knowledge needed by farmers to improve production. This study therefore, gathered information about the extent to which farmers viewed their extension agents as being effective in transferring the required information and knowledge necessary to enable them achieve optimal production in farming. Hence, the study assessed the perception of farmers' on effectiveness of extension agents in Osun State. The specific objectives are to ascertain the frequency of contact between farmers and extension agents as well as determine the respondents' perception of extension agents' knowledge/mastering of subject matters related to agricultural production.

Methodology

The study was conducted in Osun State, Southwestern Nigeria. It is an inland state in Nigeria, with its capital at Osogbo. It is bounded in the north by Kwara state, in the east by Ekiti State and partly by Ondo State, in the south by Ogun State and in the west by Oyo State. It has a tropical climate with rainforest vegetation on its southern part and a derived savannah on its northern end. It has an estimated land area of 9,251 square kilometers. The estimated human population is 3,416,959 (2006 population census) and it is characterized commercially by a dual economic focus, the bourgeoning industrial sector and a dominant agricultural sector.

Sampling Techniques

Multistage sampling technique was used to select 240 food crop farmers from 18 communities in two agricultural zones of Osun State (Ife and Iwo). First stage involved the selection of two Zones, which are Ife and Iwo randomly. Second stage involved simple random selection of three (3) blocks from each of the two ADP zones respectively making six blocks. Stage three, involved random selection of four (4) cells from each of the six blocks making 24 cells. While the last stage involved random selection of ten (10) rural households from each of the 24 cells making 240 rural households. Primary data were collected using structured interview guide. Data were analysed using frequency count, percentage and mean.

RESULTS AND DISCUSSION

Socioeconomic characteristics of the respondents in the study area

Table 1 revealed the socioeconomic characteristics such as age, marital status, education, farm size, religion and household size of the respondents in the study area. The study showed that 57.50 percent of the respondents were male with mean age of the respondent estimated at 45 years. This was in line with Ibitoye (2013) who also showed the mean age of the rural households to be 48 years. In terms of marital status, 56.67 percent of the respondents were married, 24.17 percent were single while 11.67 percent were divorced. On the educational level, 25.00 percent of the respondents had primary education, 40.00 percent of the respondents had secondary education, and those with tertiary education were 10.00 percent, while 10.83 percent of the respondent had no formal education.

Table 1: Distribution of Socioeconomic characteristics of the respondents

CHARACTERISTICS	FREQUENCY	Percentage (%)	MEAN
Age			
Less than 30	66	27.50	
30 – 40	38	15.83	
41 – 50	46	19.17	47
51 - 60	22	9.17	
Above 60	68	28.33	
Marital Status			
Single	58	24.17	
Married	136	56.67	
Widowed	28	11.67	
Divorced	18	7.50	
Gender			
Male	138	57.50	
Female	102	42.50	
Occupation			
Farming	52	21.85	
Trading/Civil servant	138	57.50	
Artisan	50	20.65	
Household size			
Less than 4	88	36.97	
4 – 8	86	36.13	7
9 - 12	52	21.85	
Above 12	12	5.04	
Education level			
Primary Education	60	25.00	
Secondary Education	96	40.00	
Tertiary Education	24	10.00	
No formal Education	60	25.00	
Religion			
Christian	78	32.50	
Islam	128	53.33	
Traditional	28	14.13	
Income (₦)			
Less than 50,000	156	65.00	49,500.50
50,000 - 100,000	60	25.00	
Above 100,000	24	10.00	
Total	240	100.00	

Perceived Assessment of Extension agent knowledge/Mastery of Subject matter

Table 2 revealed the perceived assessment of extension agent knowledge/mastery of subject matter by the respondents in the study area. Based on good knowledge of subject matter, 35.83 percent perceived them low, 32.50 percent, 21.67 percent and 55.0 percent of the respondents perceived the extension agent as low in term of beneficial of the messages, medium in term of integrate theories with practical and high in term of topics presentation respectively. About 52.50 percent of the respondents perceived extension agent as high in term of explanatory of subject matter.

Table 2: Perceived Assessment of Extension agent knowledge/Mastery of Subject matter

S/No	Assessment questions	Low Freq (%)	Medium Freq (%)	High Freq (%)
1	Have good knowledge of subject matter	84 (35.83)	34 (14.17)	120 (50.00)
2	Have a lot of new technologies	94 (39.17)	64 (30.83)	72 (30.00)
3	Messages are beneficial	78 (32.50)	44 (18.33)	116 (49.16)
4	Integrate theories and practical	118 (49.17)	52 (21.67)	70 (29.17)
5	Presentation of topics is good	86 (35.83)	22 (9.17)	132 (55.00)
6	Listen to your problem	82 (34.17)	56 (23.33)	102 (42.50)
7	Act as if they know all	78 (32.50)	96 (40.00)	66 (27.50)
8	Impose their ideas	98 (40.83)	100 (41.67)	42 (17.50)
9	Extension agent is very explanatory	84 (35.00)	30 (12.50)	126 (52.50)

Percentages are in parentheses

Perceived areas covered by Extension agents

The result of respondents' perceived areas in agricultural practices covered by extension agents in the study area showed that majority (67.50 percent) of the respondents perceived that the extension agents covered areas on production technologies as against 32.50 percent that perceived they did not cover areas on commodity crop production. About 51.67 percent, 37.50 percent, 32.50 percent and 41.67 percent perceived that the extension agents covered areas on processing/storage technology, input distribution, income generating strategies and marketing respectively. Furthermore, 58.33 percent, 21.6 percent and 25.0 percent of the respondents perceived that the extension agents did not cover areas that have to do with micro-credit, environmental and health issues.

Table 3: Perceived areas covered by Extension agents

S/No	Coverage areas	Yes Freq (%)	No Freq (%)
1	Commodity crop production technologies	78 (32.50)	162 (67.50)
2	Processing and Storage technologies	116 (48.33)	124 (51.67)
3	Input distribution	150 (62.50)	90 (37.50)
4	Income generating strategies	162 (67.50)	78 (32.50)
5	Marketing	140 (58.33)	100 (41.67)
6	Micro-Credit	140 (58.33)	100 (41.67)
7	Environmental issue	52 (21.67)	188 (78.33)
8	Health issue	60 (25.00)	180 (75.00)
9	Information and Communication technology	116 (48.33)	124 (51.67)

Percentages are in parentheses

Relevance of Extension agents' message to respondents' technological need

Table 4 revealed the distribution of respondents on their perceived relevance of extension agents' message to their technological needs. In term of message on improved varieties, 38.33 percent, 34.17 percent and 27.50 percent perceived the message as highly relevance, low relevance and not relevance respectively. In addition, in terms of messages/information on processing technology, fertilizer application and storage technology, 31.67 percent, 63.33 percent and 24.37 percent of the respondents perceived EAs message as highly relevant, low relevant and not relevant respectively.

Table 4: Relevance of Extension agents' message to respondents Needs

S/No	Relevance of EAs message	Highly relevant Freq (%)	Low relevant Freq (%)	Not relevant Freq (%)
1	Improved varieties	92 (38.33)	82 (34.17)	66 (27.50)
2	Processing	76 (31.67)	70 (29.17)	94 (39.17)
3	Fertilizer application	72 (30.00)	16 (6.67)	152 (63.33)
4	Harvesting technique	70 (29.17)	50 (20.83)	120 (50.00)
5	Storage need/problem	72 (30.25)	58 (24.37)	108 (45.38)
6	Application of herbicides and Pesticides	72 (30.00)	10 (4.17)	158 (65.83)

Percentages are in parentheses

Conclusions and Recommendation

The study assessed farmers' perception of effectiveness of extension agents in Osun state, Nigeria. The study revealed that male (57.52 percent) dominate farming activities in the study area. Majority (56.67 percent) of the respondents are married with mean age and household size estimated at 47 years and 7 persons respectively. Perceived assessment of EAs knowledge/mastery of subject matter by the respondents showed that 32.50 percent, 21.67 percent and 55.0 percent of the respondents perceived the EAs as low in term of beneficial of the messages, medium in term of integrate theories with practical and high in term of topics presentation respectively. Also perceived distribution of the respondents based on relevance of EAs message to their technological needs or problems revealed 51.67 percent, 37.50 percent and 41.67 percent perceived that the extension agents covered areas on processing/storage technology, input distribution, income generating strategies and marketing respectively highly relevant, low relevant and not relevant respectively. The study recommends training program for extension agents in Osun state to boost their knowledge on varieties of subject matter relating agricultural production. Also, proper monitoring of extension agents from time to time and provision of incentives for them, which will serve as motivation.

References

Agbamu, J.U. (2007). Essentials of Agricultural Communication in Nigeria. Malthouse Press Limited Lagos. pp. 20-24, 91-93.

Apantaku, S.O. and Oyegunle, J. O. (2016). Reports from the Field: Challenges of Agricultural Extension Agents in Ogun State Nigeria. Paper Presented at the 7th GFRAS. (Global Forum for Rural Advisory Services) Annual Meeting. 3-6 Oct. Fini Hotel, Limbe, Cameroon.

Codjoe, F.N.Y., Brempong, S.A., Boateng, D.O. (2013). Constraints facing cocoa based agricultural knowledge and information system in Ghana: Perception of cocoa farmers in the Eastern Region of Ghana. American Open Journal of Agricultural Research. 1 (8), 1 – 11.

Ezeh, A N. (2013). Extension agents' access and utilization of information and communication technology (ICT) in extension service delivery in South East Nigeria. Journal of Agricultural Extension and Rural Development. 5 (11). 266 276.

Gwary, M. M., Donye, A. O., Wakawa, R. C. and Shallangwa, M. D. (2013). Constraints to extension service delivery in the production, processing and marketing of gum Arabic in Borno State, Nigeria. Agriculture and Biology Journal of North America. 4(2): 126 131.

Ibitoye, S.J. (2013). Survey of the Performance of Agricultural Cooperative Societies in Nigeria. Eur. Scientific J. (ESJ), 8928: 98-114.

Ijeoma, M. C. and O. M. Adesope (2015). Effect of personality types of extension personnel on their job performance in Rivers State Agricultural Development Programme. Journal of Agricultural Extension. 19 (1), 1- 13

Iwena, A.O. (2008). Influence of training on farmer's productivity in poultry production in Osun State, Nigeria. International Journal of Poultry Science, 12 (4): 239-244

Osun State Agricultural Development Programme (OSSADEP). (2015). Staff record of Oyo State Agricultural Development Programme (OSSADEP).

25 SOCIOECONOMIC FACTORS INFLUENCING THE KNOWLEDGE AND ATTITUDE OF MAIZE FARMERS ON THE SAFE USE OF AGROCHEMICAL IN AGAIE AND BIDA, NIGER STATE, NIGERIA

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ABSTRACT

The study accessed the Socioeconomic factors influencing the knowledge and attitude of Maize farmers on the safe use of agrochemical in Zone I, Niger State, Nigeria. To achieve the study objectives, 4-stage sampling technique was used to randomly select 110 maize farmers for the study. Data were collected using questionnaire, complimented with interview schedules, and analyzed using descriptive statistics and Probit regression model. Based on the findings of the research, it was discovered that the mean age of the respondents were 42 years, 85% of the maize farmers were male, 89% were married, mean number of dependents of the maize farmers was 8. The mean of total years spent in school was 10 years, about 95% had no training on agrochemical handing while 92% had no extension contact. About 24% of the maize farmers use agrochemical to increase yield, with fertilizer as one of the major agrochemicals used. More so, 24% of the respondents used safety face mask, 29% claimed that Personal Protective Equipment use slows one down, while on knowledge and attitude, knowledge that agrochemical use improves crop yield had mean score of 2.05 and knowledge of agrochemical hazards had mean score of 2.01. Sex, marital status, level of education and farm size were positively significant while maize farming experience, source of capital and amount of credit where negatively significant at different probability levels. The study recommends that trainings on safe agrochemical use should be organized for farmers by extension agencies, since experience does not increase awareness.

Keywords: Maize farmers, Knowledge and Attitude, Agrochemical and Safe use

INTRODUCTION

Agrochemicals are chemicals (pesticides and fertilizers) that are used to boost agricultural production. They are used as soil conditioners, acidifiers, nutrients and they are also used to manage diseases caused by fungi, bacteria, pests and viruses, thereby improving agricultural productivity. Agrochemical use has led to increased food production (Omari, 2014).. Nevertheless, exposures to other organisms during the periods of application, including human beings, is poorly controlled (Apeh, 2018). Maize (*Zea mays*) has become a very important staple food that is being consumed by millions of Nigerians. Researches in the production and marketing of maize in various parts of the nation have shown the increasing importance of this crop. However, the continued cultivation of maize as a staple food is threatened by certain problems, such as those of pest and diseases. The use of agrochemical is not without safety or precautionary routines and practices contained on the labels and also supported by relevant national and international agencies in every country (e.g. WHO, Federal Environmental Protection Agency (FEPA), National Environmental Standards and Regulations Enforcement Agency (NESREA) etc, in Nigeria) that are expected to keep farmers from ill health related problems (Mc Arthur and Mc Cord, 2014). Hence this study tends to find out the Socio-economic factors influencing the knowledge and attitude of maize farmers on the safe use of agrochemical in Zone I, Niger State, Nigeria. The specific objectives are describe the socio-economic characteristics of maize farmers in the study area, to identify the various uses of agrochemical, type of agrochemical and personal protective equipment (PPE) used by the respondents in the study area; determine the knowledge and attitude level of respondents on the safe use of agrochemical in the study area; determine the socio-economic factors influencing the knowledge and attitude of the respondents.

Table 1: Distribution of maize farmers in Niger State

ZONE	Local Government Area (LGA)	Name of Communities/Villages	Sample Frame	Sample Size (20%)
I	Bida	Bida	205	41
		Dabarako	110	22
	Agaie	Nami	122	24
		Jipo 1	115	23
	Total		552	110

Source: Niger State Agricultural Mechanization and Development Agency, 2018.

Analytical Tools

Descriptive statistics was used to achieve *objective one (i) and two (ii) while Probit regression model was used to achieve objective three (iii).*

RESULTS AND DISCUSSION

The result revealed that the mean age of the respondents was 42 years,85% of the maize farmers were male, 89% were married, mean number of dependents of the maize farmers was 8. The mean of total years spent in school was 10 years, about 95% had no training on agrochemical handing while 92% had no extension contact. The study is in line with the findings of Tijjani *et al*., (2018) who reported that respondents in the in Jere Local Government Area of Borno State where male, with mean household size of 8 and mean age of 39. Findings from this study also reveals that 24.02% of the respondents used agrochemical to increase yield, 22.70% used agrochemical to improve quality of crop. Ladapo *et al*., (2020) reported that agrochemical increase yield.

Table 2: Distribution of respondents according to reasons for agrochemical use

Reason	Frequency	Percentage
Increase yield	110	24.02
Improve quality of crop produce	104	22.70
Control pest and diseases	104	22.70
Improve appearance of farm produce	59	12.88
As advised by extension agent	81	17.69

Note Multiple responses recorded   Source: Field survey, 2021.

About 31% of the respondents used fertilizer, 30% used herbicide and 27% used insecticide, while only 8% used fungicide. This implies that the respondents use more of fertilizers than any other agrochemical. This finding does not correspond with the findings of Mengistie *et al*., (2017), who reported that in vegetable farming, insecticides (58 %) are the mostly used agrochemicals due to serious insect pests in vegetable production.

Table 3: Distribution of respondents according to types of agrochemical used

Agrochemical	Frequency*	Percentage (%)
Fertilizer	110	31.70
Herbicide	106	30.55
Fungicide	31	8.93
Insecticide	96	27.67
Nematicide	2	0.57
Rodenticide	2	0.57

Note; * Multiple responses recorded   Source: Field survey, 2021

Furthermore, findings reveal that about 24% of the respondents used safety face mask, 16.4% used safety boots, 15.2% used safety overall, 15.2% used safety hand gloves, 12.6% used safety nose mask, 9.1% used safety goggles, while 7.6% used safety hat. This implies that the respondents make use of safety face mask more than any other protective equipment, this is probably due to the Covid 19 protocol that was compulsorily put in place to avoid its spread, and this also helped to inform many about the ability of one to contact health problems from the air. Therefore, they may now also have dread for chemicals that are applied in the air (whether in powdery or liquid form). Fadlullah, *et al*. (2015) reported in their study that farmers do not wear protective clothing,

Table 4: Distribution of respondents according to use of Personal protective equipment/clothing (PPE)

Safety PPE	Frequency	Percentage (%)
Safety overall	40	15.2
Safety boot	43	16.4
Safety goggle	24	9.1
Safety hat	20	7.6
Safety nose mask	33	12.6
Safety hand gloves	40	15.2
Safety face mask	63	23.9

Note Multiple responses recorded Source: Field survey, 2021.

On the reasons why farmers do not use PPE, 29% of the respondents claimed that PPE use slows one down, 22% claimed it is not comfortable, .17% claimed they don't see need for one, 16% claimed it is not available and 14% claimed is too expensive. This could be due to the nature the PPE, which could be quite burdensome, the claims of seeing no need shows complete ignorance. Khalid *et al.* (2013) who reported that 87% of the farmers apply fertilizer to their crop.

Table 5: Distribution of respondents according to reasons why respondents do not use PPE

Reason	Frequency	Percentage (%)
Too expensive to afford	29	14.0
Not available	34	16.4
Not comfortable	46	22.2
Slows one down	61	29.5
Don't see need for one	37	17.9

Source: Field survey, 2021.

Further analysis reveals the response of the farmers as regards their knowledge and attitude; knowledge that agrochemical use improves crop yield (mean=2.05), knowledge of agrochemical hazards (mean=2.01), trained on PPE use and handling (mean=1.88), Knowledge of the name of the agrochemical used (mean=1.85), knowledge that not all agrochemical have the same adverse effects (mean=1.78) while trained on handling and use of agrochemical (mean=1.6).

Table 6: Distribution of respondents' knowledge and attitude level

Knowledge and attitude	NK(1)	K(2)	VK(3)	WS	Mean	Rank	Decision
Agrochemical use improves crop yield	26(26)	52(104)	32(96)	226	2.05	1st	Knowledgeable
Knowledge of agrochemical hazards	24(24)	61(122)	25(75)	221	2.01	2nd	Knowledgeable
Trained on PPE use	37(37)	37(74)	32(96)	207	1.88	3rd	Not knowledgeable
Knowledge of the name of agrochemical used	25(25)	55(110)	23(69)	204	1.85	4th	Not knowledgeable
Not all agrochemical have the same adverse health effects	37(37)	60(120)	13(39)	196	1.78	5th	Not knowledgeable
Consequences of mishandling agrochemical	44(44)	56(112)	9(27)	183	1.66	6th	Not knowledgeable
Trained on handling and use of agrochemical	57(57)	40(80)	13(39)	176	1.6	7th	Not knowledgeable
knowledge of alternative forms of pest control	56(56)	43(86)	11(33)	175	1.59	8th	Not knowledgeable

Note: NK; Not knowledgeable, K; Knowledgeable, VK; Very knowledgeable Source: Field survey, 2021.
Socio economic factors influencing the knowledge and attitude of respondents

The Probit model revealed that sex was significant at 5% implying that the more males are involved in farming the more awareness is created about agrochemical use Ndaghu *et al.* (2017); Abayomi, (2018) reported that most farmers in the study areas where married and tends to comply with agrochemical safety practices. Marital status was significant at 10% implying that the more married farmers are involved, the higher the knowledge level, this could be due to the fact that there is a sense of responsibility attached to married people. Hence, they need to take care of themselves not just for their sakes, but also their spouse and family at large. Level of education was significant at 10% implying that the more educated the farmers are the more their knowledge level increases. Maize farming experience was significant but negatively at 10% which implies that increase in farming experience does not necessarily increase knowledge level. Because farmers can have experience even in ignorance and can continue in a wrong direction for a long time. Farm size was positively significant at 1% implying that the more hectares a farmer has the more his knowledge level is increased. This is because, as expansion takes place the chances of meeting more extension agents, other farmers increase thereby causing a positive change to take place. Source of capital and amount of credit were significant but negatively at 5% which implies that the amount did not influence the knowledge level of farmers. This could be because many farmers tend to receive loans or grants and channel it to family affairs/problems and not just for farm operations, this in turn affects their productivity in the farm.

Table 7: Probit model estimates of Socio economic factors influencing the knowledge and attitude of respondents

Variables	Coefficient	t-value	P-value
Age	-0.0005	-0.01	0.990
Sex	1.1772	2.12	0.034**
Marital status	0.4642	1.67	0.096*
Number of children	-0.0956	-1.23	0.220
Level of education	0.1554	1.67	0.096*
Maize farming experience	-0.0517	-1.75	0.081*
Farm size	2.2119	2.72	0.007***
Source of capital	-0.5767	-2.03	0.043**
Amount of credit	-0.00002	-2.27	0.023**
Amount spent on pesticide/herbicide	0.00003	0.63	0.528
Amount spent on fertilizer	5.15e-06	0.22	0.823
Constant	-0.9574	-0.64	
Source of labour	-0.3898	-1.25	0.211
Extension agent visit	0.3201	1.53	0.127
LR Chi^2 (13)			
Prob > Chi^2 = 0.0000			
Pseudo R^2 = 0.3391			
Log likelihood = 43.83297			

Source: Field survey, 2021. *** Significant at 1%, ** Significant at 5% and *Significant at 10%

Recommendations

i. Extension programs strictly based on the peoples dialect and traditions should be held to help the uneducated farmers understand and catch up with others.
ii. Extension agents should sensitize farmers on need to use personal protective equipment (PPE) and training on safe agrochemical use should be organized for farmers, since experience does not increase awareness
iii. Agencies producing personal protective equipment and clothing, should manufacture new and moderate or more flexible design/style for PPE products to enable farmers be more comfortable wearing them on.

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References

Abayomi, S. O. (2018). Cocoa Farmers Compliance with Safety Precautions in Spraying Agrochemical and Use of Personal Protective Equipment (PPE) in Cameroon. *International Journal of Environmental Research and Public Health.4(1),46-55.*

Apeh, C. (2018). Farmer's perception of the health effects of agrochemicals in southeast Nigeria, *Journal of health and pollution (J H & P)* 8, 19.

Fadlullah, O. I., Atala, T. K., Akpoko, J. G., & S. A. Sanni,S. A. (2015). Adoption of recommended agrochemical practices among crop farmers in Kaduna and Ondo States, Nigeria. *Journal* *of Agricultural Extension, 19 (1), 8-13.*

Khalid, A. A., Sami, S. M. H. & Monif, M. A. (2013) Factors Affecting Agricultural Sustainability A Case Study of Hail Region,Kingdom of Saudi Arabia *Asian Journal of Agriculture and Rural*

Development, 3(10), 674 -687.

Ladapo, H. L., Aminu, F.O., Selesi, O. S. &Adelokun, I. A. (2020). Determinants of the effects of Pesticide use on the health of Rice Farmers In Kwara State, Nigeria. *Journal of Research in Forestry, Wildlife & Environment, 12(3): 198-205.*

Mengistie, B.T., Mol, A.P., & Oosterveer, P. (2017). Pesticide use practices among small holder vegetable farmers in Ethiopian central Rift valley. *Environment, Development and Sustainability, 19 (1), 301-324.*

Mc Arthur, J. W., & Mc Cord, G. C. (2014). ‘‘Fertilizer growth: Agricultural inputs and their effects in economic development. ‘Global Economy and development Working Paper No. 77. Booking Institute: Washington, DC

Ndaghu, G. M, Bunu, B. & Dire, I. (2017). Perception of health hazards associated with agro chemicals use among arable crop farmers in Mubi Agricultural zone, Adamawa State, Nigeria. *International Journal of Agricultural Extension and Rural Development Studies. 4(2), 17-24.*

Omari, S. (2014). “Assessing farmers' knowledge of effects of agrochemical use on human health and the environment: a case study of Akuapem South Municipality, Ghana,” *International Journal of Applied Sciences and Engineering Research*. 3(2), 87-92.

Tijjani, H., Tijjani, B. A., & Audu, A. (2018). Socio-economic determinants of vegetable farmers' awareness of
safety measures in pesticide use in Jere local government area, Borno State, Nigeria *.Agrosearch, 18 (1), 66 – 76.*

26 A REVIEW ONEFFECTS OF BIOFORTIFIED PRO-VITAMIN A MAIZEADOPTION ON FARMER'SLIVELIHOODSTATUS IN NIGER STATE NIGERIA

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Abstract

Food and nutrition insecurities are the primary challenges in most developing countries especially in Sub-Saharan Africa (SSA). Increasing maize productivity has been identified as one of the strategies to curb food insecurity in SSA.The study reviewed the Bio-fortified pro-vitamin A maize adoption on farmer's livelihood status. Systematic review was adopted and all the relevant documents (research articles and book chapters) were sorted according to laid-down eligibility criteria. Fifty (50) articles and book chapters containing relevant and useful information were included in this review.From the review of related literature, it can be concluded that pro-vitamin A-biofortified maize (PVABM) was accepted by consumers regardless of its orange color and farmers are willing to cultivate pro-vitamin-a maize variety in Kwara State, Nigeria. Also, the level of adoption of Vitamin A bio-fortified Maize variety was low. Age, household size, level of education, farming experience, labour availability, contacts with extension agents, farm size, off-farm income and membership of associations were the major factors influencing the adoption of bio-fortified pro-vitamin A maize. The study therefore recommended that relevant stakeholders (State government, Non-governmental organization and community based organization) should intensify efforts to sensitizing farmers on the relative advantage of bio-fortified pro-vitamin A maize and the price should be subsidized for ease of adoption.

Keywords: Biofortified; pro-vitamin; livelihood; adoption; maize

Introduction

Maize is the global leading cereal in terms of production, with 1,016 million metric tons (mmt) produced on 184 million hectares (m/ha) globally (FAOSTAT, 2013). Maize is produced globally across temperate and tropical zones and spanning all continents. Maize is one of the three leading global cereals that feed the world (Shiferaw *et al.*, 2011). Maize, together with rice and wheat, dominate human diets (Ignaciuk and Mason-D'Croz, 2014) and provide at least 30% of the food calories of more than 4.5 billion people in 94 developing countries. Maize alone contributes over 20% of total calories in human diets in 21 low-income countries, and over 30% in 12 countries that are home to more than 310 million people. Out of the 22 countries in the world where maize forms the highest percentage of calorie intake in the national diet, 16 are in Africa (Nuss and Tanumihardjo, 2011). Nigeria is the second largest maize producer in Africa, after South Africa, with an estimated 10.79 million metric ton produced in 2014 (FAOSTAT, 2014). Despite its high production volumes, Nigeria's average maize yield of 1.8 million metric ton/ hectare is one of the lowest among the top 10 maize producers in Africa. It lags behind countries such as Egypt and South Africa where the yields are 7.7 million metric ton / hectare and 5.3 million metric ton/ hectare respectively (FAOSTAT, 2014).

Food and nutrition insecurities are the primary challenges in most developing countries especially in Sub-Saharan Africa (SSA). Increasing maize productivity has been identified as one of the strategies to curb food insecurity in SSA. This is because maize is widely produced and consumed in this region, has higher yield potential and more responsive to management than other cereal crops like sorghum and millet grown in SSA (Badu-Apraku *et al.*, 2011).

Bio-fortification is a new public health intervention that seeks to improve the micronutrient content of staple foods consumed by the majority of poor people using conventional plant-breeding techniques in order to make a measurable impact on the magnitude of micronutrient malnutrition (Meenakshi *et al.*,2012). According to Pérez (2019), bio-fortified crops can be classified into two main groups. Those with a visible or observable nutritional trait (crops like cassava and sweet potato that change colour from white/cream to yellow/orange when enriched with vitamin A), and those with invisible or nonvisible traits (that cannot be observed in plain sight).Since the introduction of Pro Vitamin –A maize in the country, few studies have been conducted to assess its impact on the income of the farmers particularly in the study area and with great variation in the scope of coverage. This has constituted a gap in terms of knowledge on the significance of the Pro VitaminA maize on the livelihood of the farmers. Therefore this study reviewed some related literature on Bio-fortified pro-vitamin A maize adoption on farmer's livelihood status and specifically reviewing some related literature on the perception of the farmers on Bio-fortified Pro-Vitamin-A Maize, adoption level of Biofortified Pro-Vitamin A maize and factors influencing adoption of biofortified maize.

Methodology

Systematic review was adopted for this review. Information on Bio-fortified Pro-Vitamin-A Maize were retrieved from electronic database which include Google Scholar, Research Gate, and Semantic Scholar, using search terms of "perception of farmers on Bio-fortified Pro-Vitamin-A Maize", adoption level of Biofortified Pro-Vitamin A maize", and livelihood status of the farmer. A database was created for the articles, books, and conference papers published from 199 to 2020 obtained. Based on the eligibility criteria as regards their relevance (unavailability of full text or not published in English), fifty (50) articles and book chapters containing relevant and useful information were included in this review. The study was carried out in three phases. The first phase describes the perception of the farmers on Bio-fortified Pro-Vitamin-A Maize, the second phase described the adoption level of Biofortified Pro-Vitamin A maize while the third phase involved studies on factors influencing adoption of biofortified maize.

Perception of the farmers on Bio-fortified Pro-Vitamin-A Maize

A number of studies have been conducted looking at farmers' perceptions, consumer acceptance, breeding and the potential impact of provitamin A-biofortified maize (PVABM) in combating micro nutritional malnutrition. These studies have primarily been conducted in the sub-Saharan region, as per the HarvestPlus programmed studies conducted on PVABM have shown that there is the potential for this maize to be accepted by rural communities (Egesel *et al.*, 2003). Thus, along with all the previously noted benefits of PVABM, researchers should not overlook the current smallholder farming systems in rural communities, where farmers utilize the local maize landraces in their marginal agricultural land. Farmers will need to be convinced to introduce PVABM into their farming systems. Farmers usually do not adopt improved maize hybrids (Mills *et al.*, 2017).

The main cause for this could be the lack of consideration of farmers' preference in the development of these hybrids. Farmers have different preferences and select maize for different traits and the most preferred trait for selection is yield. Farmers should be considered in the production of new hybrids, as their willingness to adopt and incorporate the product is important (Mbata *et al.*, 2009). Stevens and Winter–Nelson (2008) assessed the acceptance of provitamin A-biofortified maize (PVABM) through taste and trading. Their findings showed that PVABM was accepted by consumers regardless of its orange color. However, these findings may vary between countries and regions. A study by Olayinka *et al.*(2020) reported in their work farmers' willingness to cultivate pro-vitamin-a cassava variety in Kwara State, Nigeria. The study showed that about half of the respondents had high knowledge about the improved cassava variety and a vast majority expressed willingness to cultivate it. Sex and knowledge level had significant association with willingness to cultivate pro vitamin A maize with female farmers found to be about 3 times more likely willing to cultivate than male.

Adoption level of Biofortified Pro-Vitamin A maize

Many factors were identified as possible determinants of the adoption or acceptance of the pro-vitamin A biofortified crop in Nigeria. According to De Steur *et al.* (2012) who reported that Nutritional information and visible trait (yellow colour) is one known property of vitamin A biofortified crops that consumer were well aware that this crop differs from their local variety acceptance/adoption was now based on how well informed they are of its nutritional advantage against the high incidence of the vitamin A micronutrient deficiency in their communities (De Steur *et al.*,2010*;* Onyeneke *et al.*,2019). This nutritional information proved a significant factor in consumer preference and willingness to pay for yellow coloured pro-vitamin A biofortified maize crop in Nigeria (especially in Imo State of the South-East) (Oparinde *et al.*, 2016; Birol *et al.*, 2015). The information of the nutrition and health benefits content and length of nutritional campaigns remains an important factor, just as Bouis *et al.(*2017) show the integration of biofortified food to children's diet, thus increasing adoption.

Asfir (2016) in their work on determinants of adoption of Vitamin A bio-fortified Cassava variety among farmers in Oyo State, Nigeria revealed that the level of adoption of Vitamin A bio-fortified Maize variety was low as access to media, contact with extension agents, among others are the determinants of adoption of vitamin A bio-fortified maize variety in their study area.

Accordingly, De Groote *et al*. (2016) found that adopters ranked agronomic performance as more important than nutritional benefits for adoption. Thus, farmers who are aware of the variety but lack knowledge of its nutritional attributes may not adopt bio-fortified crops. However, the extent to which knowledge of the nutritional benefits and awareness of varieties affects the adoption of bio-fortified varieties has not been quantified. While this gap has been acknowledged in previous research on the adoption of bio-fortified crops, it has hardly been addressed in any empirical study. This study evaluates the effect of variety awareness and nutrition knowledge the on adoption of bio-fortified crop varieties in the Kisii and Nyamira counties of Kenya.

Hao *et al.* (2015) in their study on extension and adoption of bio-fortified crops: Quality protein maize in Africa revealed that the farmers in project communities participated in extension activities in all countries except Kenya. In these communities, familiarity with QPM was high again except for Kenya, but understanding of their nutritional benefits was much lower. In all countries, farmers evaluated quality protein maize (QPM) varieties to be good or better than conventional varieties

(CV) for post-harvest characteristics. For agronomic characteristics, however, QPM varieties scored better than CV in Uganda, about the same in Tanzania, but less in Ethiopia. Adoption patterns differed widely between the countries: in the project areas it varied from 70% in Uganda, 30% in Tanzania to none in Kenya. In the control areas, adoption was only observed in Uganda. Factors that significantly influenced adoption were farmers' participation in extension activities, farmers' agronomic and post-harvest evaluation of quality protein maize (QPM) versus conventional maize (CM) and their understanding of the nutritional benefits of QPM. Evaluation for agronomic performance was found to be more important than knowledge of nutritional benefits, thus favoring the first approach. A reliable seed supply was, however, found to be a basic condition for adoption. More also, De Groote *et al*. (2016) find that Quality protein maize (QPM) farmers showed high familiarity with the varieties, but low understanding of their nutritional attributes and benefits – an indication of failure to disseminate information on the nutritional benefits.

Factors Influencing Adoption of Biofortified Maize

In general, factors that will influence a farmer's ability and willingness to adopt agricultural technologies involve both farm-specific aspects (i.e., the characteristics of the farmers and the resources at their disposal), and circumstances related to the biophysical and socio-economic context of the farming operation. Technologies may at times be rejected not because of their intrinsic qualities, but rather because they are not compatible with these factorsInternational Maize and Wheat Improvement Center (Remidius 2020). Information regarding the existence of new agricultural technology is of course a prerequisite for technology adoption. Such information can be obtained from various external sources, such as extension agents, fellow farmers or different media such as television or radio. Importantly, farmers will also require the necessary information to assess the suitability of the technology for their farming system and to understand the potential risks associated with the use of the technology. For instance, farmers may be uncertain about the profitability of the new technology or differences in economic returns between new and old technologies. Such uncertainties may arise due to insufficient knowledge about yields of new technologies, the types and costs of needed inputs, or expected market prices and demand for the produce (Abadi and Pannell, 1999).

Weather conditions and climatic shocks also increase uncertainty and risk, in particular among subsistence farmers who are dependent on rainfall (Abadi and Pannell, 1999). Another influencing factor in technology adoption is the farmers attitude to risk. In this context, the farmers attitude to risk i.e., whether they are risk avert, risk neutral or risk preferring is an important determinant for their willingness to adopt new technologies (Marra *et al.*, 2003).

Chete,(2021) reveal that adoption of improved maize seed varieties among the households was positively influenced by age, household size, level of education, farming experience, labour availability, contacts with extension agents, farm size, off-farm income and membership of associations. However, the study concluded that improving farmers' education, expanding coverage and depth of extension services and strengthening farmer associations are useful policy actions for promoting adoption of improved maize varieties. It is also important to address availability, accessibility and affordability issues constraining adoption, enhance credit access and mitigate risk perceptions.

According to Olusegun *et al.* (2016) in their studies onfactors influencing adoption decisions of maize farmers in Nigeria revealed that farmers across the entire agro-ecological regions of country share some negative sentiments regarding adoption of improved maize variety (IMV). Renewed emphasis on interventions that would enable farmers gain more access to farmland, and promote formal education and extension service are advocated. An attempt to incorporate variables that capture farmers' perception/experience on agro-climatic/ ecologically related concerns in adoption study could aid better understand of what drives farmers' adoption decisions across the country especially in the light of the emerging climate change issues and its implication on food production.

Olatade *et al.* (2016) in their work on how does farmers' characteristics affect their willingness to adopt agricultural innovation the case of bio-fortified cassava in Oyo state, Nigeria revealed that farmers' willingness to adopt bio-fortified cassava in the study area were influenced mainly by gender, source of inputs, marital status, access to extension officer and membership of farmer organization.

Conclusion and Recommendations

From the review of related literature, it can be concludedpro-vitamin A-biofortified maize (PVABM) was accepted by consumers regardless of its orange color and farmers are willingness to cultivate pro-vitamin-a maize variety in Kwara State, Nigeria. Also the level of adoption of Vitamin A bio-fortified Maize variety was low and age, household size, level of education, farming experience, labour availability, contacts with extension agents, farm size, off-farm income and membership of associations were the major factors influencing the adoption of bio-fortified pro-vitamin A maize. The study therefore recommends that relevant stakeholders (State government, Non-governmental organization and community based organization) should intensify efforts to sensitizing farmers on the relative advantage of bio-fortified pro-vitamin A maizeand the price should be subside for ease of adoption.

REFERENCES

Abadi, A. k. G & Pannell D. (1999) A conceptual frame work of adoption of an agricultural innovation, *international association of agricultural economist*, (2), Pp 145 – 154.

Asfir S. S. (2016). Determinants of rural households' livelihood strategies: Evidence from Western Ethiopia. *Journal of Economics and Sustainable Development*,7 (15):103-109.

Badu-Apraku, B., Oyekunle, M., Obeng-Antwi, K., Osuman, A. S., Ado, S. G., Coulibay, N. & .Didjeira, A. (2011). Performance of extra-early maize cultivars based on GGE biplot and AMMI analysis. *The Journal of Agricultural Science*, 150(04), 473-483.

Birol E, Meenakshi J, Oparinde A, (2015) Developing country consumers' acceptance of biofortified foods. *Food Security* 7: 555–568.

Bouis, H. and Saltzman, A. (2017). Improving nutrition through biofortification: a review of evidence from HarvestPlus, 2003 through 2016. *Global Food Security* 12:49–58.Chete O. B. (2021) Factors influencing adoption of improved maize seed varieties among smallholder farmers in Kaduna State, Nigeria, *Journal of Agricultural Extension andRural Development*, Vol.13(2), Pp 107-114.

De Groote, H.; Tomlins, K.; Haleegoah, J.; Awool, M.; Frimpong, B.; Banerji, A.; Meenakshi, J.V. (2016): Assessing rural consumers' WTP for orange, biofortified maize in Ghana with experimental auctions and a simulated radio message. In Proceedings of the 2010 AAAE Third Conference/AEASA 48th Conference, Cape Town, South Africa, 19–23 September 2010; pp. 19–23.

De Steur H, Gellynck X, Storozhenko S. (2010) Willingness to accept and purchase genetically modified rice with high folate content in Shanxi Province, China. *Appetite* 54: 118–125.

De Steur, H., Gellynck, X., Van Der Straeten, D., Lambert, W., Blancquaert, D., Qaim, M. (2012). Potential impact and cost-effectiveness of multi-biofortified rice in China. *New Biotechnology*, *29*(3), 432-442.

Egesel, C.O.; Wong, J.C.; Lambert, R.J.; Rocheford, T.R (2003): Gene Dosage Effects On Carotenoid Concentration in Maize Grain.*Maydica* (48), Pp 183–190.

FAOSTAT (2014). http://Faostat.fao.org

FAOSTAT. (2013). Guatemala Maize Area Harvested. Rome, Italy: Food and Agriculture Organization of the United Nations. http://faostat.fao.org/site/

Hao, H.; Zhang, J.; Li, X.; Zhang, H.; Zhang, Q. (2015) Impact of livelihood diversification of rural households on their ecological footprint in agro-pastoral areas of northern China. *Journal of Arid Land* 2015, 7, 653–664.

Ignaciuk, A. & Mason-D'Croz, D. (2014). "Modelling Adaptation to Climate Change in Agriculture," OECD Food, Agriculture and Fisheries Papers 70, OECD Publishing.

Marra, M., Pannell B. D. J., Ghadim, A. A. (2003) The economics of risk, uncertainty and learning in the adoption of new agricultural technologies: where are we on the learning curve. *Journal agricultural systems* 75, 215–234

Mbata, T.I.; Ikenebomeh, M.J.; Alaneme, J.C. (2009): Studies on the microbiological, nutrient composition and antinutritional contents of fermented maize flour fortified with bambara groundnut (Vigna subterranean L). *Afircan. Journal of. Food Science.* (3), Pp 165–171.

Meenakshi JV, Banerji A, Manyong V, Tomlins K, Mittal N, Hamukwala P., (2012): Using A Discrete Choice Experiment To Elicit The Demand For A Nutritious Food: Willingness-To-Pay For Orange Maize In Rural Zambia. *Journal of Health Economics*. 31(1):62-71

Mills, D.J., Tilley, A., Pereira, M., Hellebrandt, D., Pereira Fernandes, A.; Cohen, P.J. (2017) Livelihood diversity and dynamism in Timor-Leste; insights for coastal resource governance and livelihood development. Mar. Policy, 82, 206–215.

Nuss, E.T. And Tanumihardjo, S.A. (2011). Quality Protein Maize For Africa: Closing The Protein Inadequacy Gap In Vulnerable Populations. American Society For Nutrition. *Journal of Advance.Nutrtion .(*2):217-224.

Olatade, K. O., Olugbire, O. O., Adepoju, A. A., Aremu, F. J., &Oyedele, P. B. (2016) How does farmers' characteristics affect their willingness to adopt agricultural innovation. The case of biofortified cassava in Oyo State, Nigeria, *International Journal of Science and Technology*, Bahir Dar- Ethiopia. 5 (2), 104-112

Olayinka, J., Yusuf, O., Yusuf A., OloladeLatifat A. O., Oluwafemi L. A., Ibrahim F. (2020) Farmers' willingness to cultivate pro-vitamin-A cassava variety in Kwara State, Nigeria. *Journal of Agricultural Extension.* V24 (3), 106-114

Olusegun, A. F., Dare A., Begho T. (2016) Factors influencing adoption decisions of maize farmers in Nigeria, *International Journal of Food and Agricultural Economics.* Vol. 2 No. 3 pp. 45-54.

Onyeneke R. U., Umunna A. M & Chidi A. F. (2019). Biofortification in Nigeria: A systematic review, *AIMS Agriculture and Food*, 4(4): 892–906.

Oparinde A, Banerji A, Birol E, Ilona P., (2016). Information and consumer willingness to pay for biofortified yellow cassava: evidence from experimental auctions in Nigeria. *Agricultural Economics*. (47): Pp 215-233.

Pérez, S. S. (2019). Consumer acceptance of iron biofortified varieties of staple food crops, dissertation submitted in fulfillment of the regulations to acquire the degree faculty of agricultural Sciences institute of agricultural sciences in the Tropics (Hans-Ruthenberg-Institute) University of Hohenheim.

Remidius, D. R, Jose Falck- Z; Wrike, W. S; Zambrano, P; Haji, S; Chambers, J; Hillary, H; Gerald, L. (2020): Ex-ante economic assessment of impact of GM maize and cassava on producers and consumers in Tanzania, IFPRI Discussion Paper.

Shiferaw B., Hellin, J. and Muricho, G. (2011). Improving Market Access and Agricultural Productivity Growth in Smallholder Agriculture in Africa: What Roles for Producer Organizations and Collective Action Institutions? *Food Security* 3(4), 475-489.

Stevens R., A Winter-Nelson., (2008). Consumer Acceptance of Provitamin A-Biofortified Maize in Maputo, Mozambique. Food Policy. 33: 341−351

27 YOUTH LED ENTERPRISES UNDER INPUT SUBSIDIES ON RICE PRODUCTION IN NIGER AND BENUE STATES, NIGERIA- A REVIEW

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Abstract

Despite the contribution of agriculture to Gross Domestic Product in Nigeria, food production has not been able to keep pace with population growth. Rice production in Nigeria no longer keep with population growth. Thus, creating a wide gap between the demand and supply of rice. Despite the immense contributions of youth on nation economy, they face a number of constraints including socio-economic, institutional and cultural factors that limit their capacity of achieving their potentials. This paper review studies on the effects of input subsidies on efficiency of youth –led enterprise in rice production in Niger and Benue States, Nigeria. However, government initiated and implemented different input subsides programmes to increase land access through reforms, provide rural infrastructure, enhance credit access, and grant input subsidies and boost agricultural productivity. The reviews also intensify that Youth-Led Enterprises Under Input Subsidies on Rice Production not only improve the socioeconomic life of the people but also encourage development of vocational agriculture among the youths. The major problems faced by the youths were insufficient capital, inadequate knowledge on rice production, low output price and transportation problems. There is need for encouraging the youth through provision of improved seeds, land, credit facility, good roads and extension services.
Keywords: Economic analysis; Youth- led enterprise; Input subsidies and Rice production.

Introduction

In the literature of agricultural production in Nigeria, agriculture has been described as the most important economic sector in terms of its contribution to the GDP, after oil World Bank (2010), For example, the sector contributed about 41% of the country's Gross Domestic Product (GDP), employed about 65% of the total population and provided employment to about 80% of the rural population Agricultural Transformation Agenda (ATA) (2015). Despite the contribution of agriculture to Gross Domestic Product in Nigeria, food production has not been able to keep pace with population growth. As stated by Dorward and Ephariam (2013), food production at subsistence level especially in third world countries does not keep with the pace of rapidly growing population, when compared to advanced or developed economy. National Bureau of Statistics (NBS) (2018). Further cited that in Nigeria, as at 2023, the total population estimate stood at 222,189,589 million people, Nigeria population is equivalent to 3.64% of the total world, and Nigeria ranks number seven 7) in the list of countries by population. This figure provides an indication that Nigerian population is among the fast-growing population in the world. On the other hand, food production increases marginally at a rate lower than population growth rate. With this growing rate can Nigeria sustain its population food demand, by providing sufficient quantity and quality of food for all Dorward *et al*. (2013)

Rice production in Nigeria no longer keep with population growth. Thus, creating a wide gap between the demand and supply of rice Agricultural Transformation Agenda (ATA) (2015). This is evident in the observed food deficit and the upward trend in the price of rice in the market over the years International Fund for Agricultural Development Agenda (IFAD) (2014). Failures in agricultural input market are common in developing countries are a major constraint to productivity growth, farmers in Nigeria, Africa face particularly acute constraints with poor output prices incentives high fertilizer prices, lack of credit facilities and low knowledge on how to apply these inputs, resulting low output. The resulting effect of this imbalance between demand for and supply of food is malnutrition, low yield, poverty and deteriorating living conditions of populates World Bank (2010). Against this background, the growth of Nigeria economy with reference to agriculture has been import driven rather production driven. Consequently, there is a growing advocacy for improving Nigeria agricultural production so as to achieve sustainable food security. A lot of effort has been directed at finding appropriate institutions for organizing millions of small-scale farmers towards achieving food security (through increased food production) and agricultural mechanization is one of key.

However, there is insufficiency of empirical analysis carried out on the effects of input subsidies on efficiency of youth-led enterprises in rice value chain in Niger and Benue States. Despite the immense contributions of youth on nation economy, they face a number of constraints including socio-economic, institutional and cultural factors that limit their capacity of achieving their potentials. It is based on this back drop, that this paper review studies on the effects of input subsidies on efficiency of youth –led enterprise in rice production in Niger and Benue States, Nigeria.

Input subsidies

The agricultural sector contributed about 23 % of the country's Gross Domestic Product, having approximately 75 % share of non-oil exports earnings (Federal Ministry of Agriculture and Rural Development, 2016). Over the years, the sector has provided employment opportunities for the majority (over 70 %) of the nation's populace, especially those in rural areas (Ogbalubi and Wokocha, 2013). Due to the significance of this sector to the economic development of the country, the government was able to introduce and implement quite a lot of policies and programmes aimed at improving the sector and unleashing its potentials in the country (Nwaobiala and Ubor, 2016; Okunola, 2016). Over the years, some of these multifaceted programmes and projects include; the National Accelerated Food Production Programme (NAFPP), River Basin Development Authorities (RBDA), Operation Feed the Nation (OFN), Agricultural Credit Scheme (ACGS), Green Revolution (GR), Agricultural Development Programme (ADP), Directorate of Food, Roads and Rural Infrastructure (DFRRI), and the National Land Development Authority (NLDA) among others. In recent decades, the National Fadama Development Project, National Special Programme for Food Security, Community and Social Development Projects, and the Agricultural Transformation Agenda (ATA) were also implemented. These programmes and projects were implemented nationally to; increase land access through reforms, provide rural infrastructure, enhance credit access, and grant input subsidies and boost agricultural productivity. In recent years, there has been a resurgent interest in large-scale agricultural input subsidies across

Sub-Saharan Africa (Dorward, 2009; Hansen and Baltzer, 2011; Abubakari and Abubakari, 2014; Dorward and Chirwa, 2014). Ellis (1992) gave the conventional argument for subsidies in agricultural development, which were to promote adoption of new technologies and thus increase agricultural productivity. As reported by Chibwana *et al*. (2012) in Mali and Aloyce *et al*. (2014) in Tanzania, access to subsidised farm inputs increases farmers' productivity significantly through increase in the farm size and reduced transition cost in the adoption of new technologies. Further, according to Seck (2016), input subsidy schemes appear to be associated with increased efficiency among farmers, and this tends to validate the argument that lower input prices, as a result of the subsidy, provide incentives for farmers to use more of the inputs, which in turn translates into increased output. These agricultural inputs range from improved seeds, fertilizers and crop protection chemicals to machinery, irrigation and knowledge (Hansen and Baltzer, 2011; Nwaobiala and Ubor, 2015).

In Nigeria, agricultural input subsidy occupies a central role in the policy tools of the government (Umar *et al*., 2015). According to Takeshima and Liverpool-Tasie (2013), fertilizer subsidy alone constituted nearly 68 % of government agricultural expenditure in recent past. Agricultural inputs are a range of materials which may be used to make agricultural production possible, while input subsidies are grants given by the government to farmers in order to reduce their production cost and improve their profit margin. Over the years, the Nigerian government has been making considerable expenditure on the provision of subsidized farm inputs (especially fertilizer) in the country. The direct costs of fertilizer subsidy per Metric Ton (MT) under the Market Stabilization Scheme (MSS) was ₦ 10,261 in, 2001 and has geometrically increased to ₦ 55,000 in, 2015 under the Growth Enhancement Support Scheme (GESS). Most recently, the Government earmarked over ₦ 27 billion to provide input subsidy to 1.5 million farmers in the 2016 / 201 dry season farming input package. The cost of subsidy per farmer ranged between ₦ 22,125 to ₦ 24, 825 depending on the type of crop the farmer cultivates (Federal Ministry of Agriculture and Rural Development, 2016). This bloated volume of agricultural input subsidy has mounted a huge fiscal burden on the Federal budget over time (Ayoola and Ayoola, 2016)

Rice Production

Rice is a food security crop for meeting consumption needs globally. It is the world's most important food commodity and ranks third in Nigeria. According to Falola & Adewumi (2012), an average Nigerian now consumes 24.8 kg of rice per year, representing 9% of total caloric intake. However, although Nigeria is the largest producer of rice in West Africa yet it accounts for 20% of sub-Saharan African rice import (Yisa *et al*. 2010). This is in an attempt to meet the supply-demand gap of rice in the country. One of the major constraints to agricultural production in Nigeria is the fact that Nigerian agriculture is still being carried out through the use of physical strength, which declines with age (Ayoola and Ayoola, 2016). Therefore, involvement of the youth in agriculture, especially staple food crops such as rice, is vital to facilitate production in a manner to fill in the supply demand gap in food crops in the country. opined that youths are more often open to new ideas and practices than adult farmers. Nwaobiala and Ubor, (2015) posited that the youth are the active population of any nation and that their involvement in agricultural activities goes a long way in shaping the developmental height of a nation. They also argued that this will not only improve the socioeconomic life of the people but also encourage development of vocational agriculture among the youths. In spite of these opportunities, the youth still perceive agriculture to be non-lucrative

Youth- led enterprise

The age in which an individual is considered youth varies around the world. The United Nations and the World Bank define "Youth" as persons between the ages of 15 and 24 years (FAO, 2012). The Commonwealth Youth Programme considers the youth as young people aged 15-29. World Health Organization view "Youth" as any member of society between ages of 15 and 34 (World Bank, 2012). According to Federal Ministry of Youth Development Employment Programme (YEP), (2012), the youth comprise all young persons of ages 18 to 35years, who are citizens of the Federal Republic of Nigeria. The role played by youth in agriculture cannot be overemphasized, while agribusinesses are important generators of employment and income worldwide. Improving the sustainability of food value chains that generate income for millions of rural poor. In Nigeria, about 22% of the 77 million people is made up of youths (UNICEF, 2008). The youths are those who are under 35 years and are still receiving training from their parents. Youths in all countries constitute major human resource for development both in agriculture and technology innovation (Nwachukwu, 2008, Onuekwusi, 2003). Youth is the future of farming, since they are a subset of family farmers living in developing countries, especially young women. Young entrepreneurs who see opportunities to compete and thrive must save and invest on their own or in others' farms or businesses with a target to sell their output to earn income and pay employees.

It is also important to remember that paid employment is both a business cost and the foundation of business revenue. They invest in farm business with the expectation to get a return or to breakeven. In case of no gain, there is a high tendency to move from farming to rural and urban migration (FAO, 2012). The Food and Agriculture Organization of the United Nations (FAO) and the United Nations Industrial Development Organization (UNIDO) developed this joint programme in response to a dedicated call for accelerating efforts in the area of job creation for African youth, especially through agribusiness and entrepreneurship development. This call was made during the 2018 Conference on Youth Employment in Agriculture co-organized by the African Union, the Government of Rwanda and FAO, which took place on 20-21 August 2018 in Kigali, Rwanda, with the theme: "Youth Employment in Agriculture as a Solid Solution to Ending Hunger and Poverty in Africa: Engaging through Information and Communication Technologies (ICTs) and Entrepreneurship" This programme proposes an integrated approach for the creation of quality on- and off-farm employment and self-employment opportunities for African youth in agriculture and agribusiness. It highlights the central role of agriculture for Africa's development, while emphasizing the need for continuous empowerment of African youth to be the engine of this growth. Reduce poverty through decent employment and self-employment creation; Enhance shared prosperity and job creation through agribusiness and agro-industries; Promote sustainability through inclusive agricultural value chains and food systems.

Nigeria youth are typically engaged in everything but quality jobs; they earn low wages on account of very low levels of productivity and low capital/labour ratios, they are employed under casual or seasonal work arrangements and often face unsafe, exploitive working conditions with very limited opportunities for skills development. Particularly in rural areas, where education opportunities are limited, agriculture employs about 60 percent of the young people aged 15-35 years (Saleh, 2016). Nevertheless, there is a large and untapped reservoir of employment opportunities and entrepreneurship development in some segments of agricultural value chains and in agro-processing. The agricultural sector in Nigeria can play a key role in solving the youth employment challenge that threatens stability and growth in many countries across the

Continent. Nonetheless, for several decades the proposed interventions in support to agriculture development have yielded mixed results, and the agricultural sector had expressed its full potential in terms of contribution to the economic growth of Nigeria and the creation of employment and self-employment opportunities for millions of youths (Sallawu, 2014).

Conclusion and Recommendations

The survey found that young people were hardly ever involved in the production of rice. Their years of experience, organization membership, access to credit, source of inputs/implements, and extension contacts all had a significant impact on their involvement in rice production. Young people's ability to produce rice was mostly hampered by a lack of funding, storage space, farmland, access to information about farming techniques, and agricultural inputs. Access to microfinance institutions for youth participants in the rice production program is necessary, and the government should enforce tighter credit controls for these institutions to increase their need for capital and guarantee higher productivity

References

Abubakari, F. & Abubakari, F. 2014. Effects of Awareness of Fertilizer Subsidy on the Yield of Crops among Rural Farmers in Ghana. International Journal of Agricultural Science, Research and Technology in Extension and Education Systems (IJASRT in EESs), 4(3): 123–126.

Agricultural Transformation Agenda (ATA) (2015). Private Sector Investment in Rice Sector in Response to Government Policies in Nigeria, Presentation at the 6th General Meeting of the Coalition for African Rice Development (CARD) November 18 -19, Accra, Ghana pp2.

Aloyce, G. M., Gabagambi, D. M. & Hella, J. P. 2014. National Agricultural Input Voucher Scheme Impact on Productivity and Food Security of Smallholder Farmers in Tanzania. Journal of Economics and Sustainable Development, 5(21): 32–43.

Baltzer, K. T. and Hansen, H. (2011). Agricultural input subsidies in Sub-Saharan Africa. Copenhagen, Denmark: Ministry of Foreign Affairs

Chibwana, C., Fisher, M. & Shively, G. (2012). Cropland Allocation Effects of Agricultural Input Subsidies in Malawi. World Development, 40(1): 124–133.

Dorward, A. & Ephariam, C. (2013). The Malawi Agricultural Input Subsidy Programmed: *Intentional Journal of Agricultural Sustainability*, 9(1), 2005-6 -2008-9.

Dorward, A. (2009). Rethinking Agricultural Input Subsidy Programmes in A Changing World. London, UK: School of Oriental and African Studies, University of London

Dorward, A. & Chirwa, E. (2014). The rehabilitation of agricultural input subsidies? London, UK. London, UK: School of Oriental and African Studies, University of London.

Ellis, F. (1992). Agricultural policies in developing countries. Cambridge, UK: Cambridge University Press.

Falola A. & Adewumi MO (2012): Mobile telephony and food crop production in Nigeria: A case study of food crop farmers in Ondo State. *African Journal of Agriculture, Technology and Environment 2012*, 1(1):39-46.

FAO (Food and Agriculture Organization). (2012). Sustainable Crop Production Intensification Twenty-third Season. Rome, Italy

Federal Ministry of Agriculture and Rural Development (FMARD) (2016). *Agricultural Transformation Agenda (ATA) 2013 score Card* Federal Ministry of Agriculture and Rural Development, Nigeria wwwfmard.gov.ng

International Fund for Agricultural Development (IFAD) (2014). Implementation Manual

National Bureau of Statistics (NB S) (2018). National Bureau of Statistics Report. The Statistical Fact Sheets on Economic and Social Development, Abuja, Nigeria. Pp6-7.

Nwaobiala, C. U. & Ubor, V. U. (2016). Effectiveness of Electronic Wallet System of Growth Enhancement Support Scheme Distribution among Arable Crop Farmers in Imo State, South Eastern Nigeria.

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, 16(1): 355–360.

Nwachukwu, E.U. (2008) Determination of Efficiency of Resource Use in Swamp and Upland Rice Production System in Ebonyi State. An Unpublished M.Sc Thesis Submitted to the Department of Agricultural Economics University of Nigeria, Nsukka, Nigeria.

Ogbalubi, L. N & Wokocha, C. C. (2013). Agricultural Development and Emplyoment Generation: The Nigeria Experience. IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS), 2(2): 60–69.

Onuekwusi, O. (2003). Rural community development. In :Nwachukwu,1 and Onuekwusi, G (eds.) Agricultural Extension and Rural Sociology. Enugu, Snaap Pres LTD, pp. 163-186.

Sallawu, H. (2014). Livelihood and Income Diversification Strategies among Farm Households in Niger State, Nigeria. Unpublished MTech Thesis, Department of Agricultural Economics and Extension Technology Federal University of Technology, Minna, Nigeria.

Seck, A. (2016). Fertilizer Subsidy and Agricultural Productivity in Senegal. AGRODEP Working Paper 0024, pp. 2–31.

Takeshima, H. & Liverpool-Tasie, L. S. (2013). Fertilizer subsidy, political influence and local food prices in sub-Saharan Africa: Evidence from Nigeria. In: Agricultural & Applied Economics Association'sm2013 AAEA & CAES Joint Annual Meeting. Washington DC, USA, 1–38.

Umar, S., Oteikwu, O. P., Shuaibu, H., Duniya, K. P. & Tambari, I. W., (2015). Factors Influencing Level of Satisfaction with Growth Enhancement Support Scheme among Farm Families in Kaduna State, Nigeria. Journal of Agricultural Extension, 19(1): 10-21

World Bank (2010). Zambia Impact Assessment of the Fertilizer Support Programme, Analysis of Effectiveness and Efficiency No 54864, World Bank Africa Regional.

Yisa ES, Ogaji A, Ajayi OJ, Yusuf TL. and Shaffi A (2010): Assessment of the effect of agricultural productivity on rural household food security in Katcha Local Government Area of Niger State. *Proceedings of 11th Annual National Conference of National Association of Agricultural Economists 2010*, 280 – 286.

28 DETERMINANTS OF ACCESS TO THE AGRICULTURAL TRANSFORMATION AGENDA (ATA) PROGRAMME AND ITS EFFECTS ON RICE FARMER'S PRODUCTIVITY IN NIGER STATE, NIGERIA

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Abstract
The study evaluated the determinants of access to the Agricultural Transformation Agenda (ATA) programme and its effects on the productivities of rice farmers in Niger State, Nigeria. Primary data was used for the study and collected from three local governments of the State from a total of 194 rice farmers consisting of both beneficiary and non-beneficiary farmers of the programme. Data collected were analyzed using Logit regression model and Total factor Productivity (TFP). The results of the Logit regression shows that farm size, membership of cooperative society, level of education, age and number of extension contacts were all significant and directly related to access to the ATA and a unit increase in these variables, holding other factors constant, led to an increase in the probability of rice farmer's access to the ATA programme by 0.287, 0.332, 0.670, 0.886 and 0.951 times respectively. The result of the TFP technique shows that farm size, labour used, quantity of fertilizer applied, amount of improved seed used, quantity of agrochemicals used, amount of the Nigerian Incentive-based Risk Sharing Agricultural Lending (NIRSAL) loans collected and ATA participation were all directly related to productivity and are all significant at 1% level of probability. The study recommends that since the programme showed significant increases in the productivity of the beneficiaries when compared with the non-beneficiaries, government policies, investments and efforts in the agricultural sector would build on the successes of the ATA programme while improving on the identified pitfalls or weaknesses to be able to stimulate further increases in the growth and productivity of farmers particularly in rice subsector.
Keywords: Agricultural productivity, Total Factor Productivity, Agricultural Transformation Agenda.

INTRODUCTION

The role of agriculture in transforming both the social and economic framework of an economy cannot be over emphasized. Agriculture is a major contributor to Nigeria's Gross Domestic Product (GDP). It accounts for about one third of the Gross Domestic Product, employs about 68% of the labour force, accounts for over 70% of non-oil exports and provides over 80% of the food needs of the country (Muhammad-Lawal and Omotesho, 2008; Kolawole and Ojo, 2007). It could however be suggested that despite this importance, agricultural production and food supply in Nigeria are still lagging behind, as a result of low utilizations of modern inputs by farmers, unavailability and inaccessibility of farmlands as well as non-mechanized nature of the prevailing agricultural production system.

The Federal Ministry of Agriculture and Rural Development, FMARD (2011) noted that as part of the Federal Government of Nigeria's effort to revamp the agricultural sector, ensure food security, diversify the economy and enhance foreign exchange earnings, the FMARD embarked on a Transformation Agenda with a focus on the development of agricultural value chains, including the provision of and availability of improved inputs (seeds and fertilizer), increased productivity, as well the establishment of staple crops processing zones. It was designed to achieve a hunger-free Nigeria, through an agricultural sector that drives income growth, accelerates achievement of food and nutrition security, generates employment and transform Nigeria into a leading player in global food market to grow wealth for millions of farmers. Rice (*Oriza sativa*) is targeted as one of the major or key crops of focus under the ATA programme. Nigeria spends about ₦356b on rice importation annually making it the second largest importer of rice in the world (AfDB, 2013).

The ATA therefore, is anticipated as the vehicle that will drive self-sufficiency in food production in Nigeria, especially as it relates to rice production. However, in-spite of the prospects, hopes and promises of the ATA, there has not been adequate research at evaluating its achievements in improving the income of farmers, increasing productivity of the farmers and increasing local rice production especially in Niger State, Nigeria. This therefore makes it imperative to evaluate the determinants of the farmer's access to the programme and its effects on their productivity in the State especially as it relates to the farm level productivities of the rice farmers.

The aim of the study was to evaluate the determinants of access to the Agricultural Transformation Agenda and its effects on rice farmer's productivity in Niger State, Nigeria.

The specific objectives were to:

i. examine the determinants of access to the ATA by rice farmers in the study area;
ii. determine the effect of the ATA on the productivities of rice farmers in the study area.

METHODOLOGY

Area of Study

This study was conducted in Niger State, Nigeria. The State is located in the North-Central zone and Southern Guinea Savannah agro-ecological zone of Nigeria. The state is bordered on the North-East by Kaduna State and on the South-East by the Federal Capital Territory (FCT), Abuja. It is also bordered on the North, West, South-West and South by Zamfara, Kebbi, Kogi and Kwara States respectively. Is also shares foreign border with the Republic of Benin in the North-west. The State covers an estimated land mass of about 76,363 square kilometers, constituting about 10% of Nigeria's total land mass, of which 85% is arable land. The population of the state is put at 3,954,772 persons consisting of 2,032,998 males and 1,917,778 females (National Population Commission, 2009) and this population is projected to reach an estimated 5,853,062 persons by 2022 at a 3% annual growth rate. An estimated 85% of the population are farmers which makes farming the major occupation of the people.

Sampling Technique and Sample Size

The multistage sampling technique was used to select respondents for the study. The first stage involves the random selection of one LGA from each of the three agricultural zones in the State. The LGAs randomly selected are Bosso in Zone A, Gbako in Zone B and Wushishi in Zone C. The second stage involved the random selection of 10% of the rice-producing communities/villages in each of the local governments selected where the ATA programme were implemented. In the final stage, a proportionate to size sampling technique was used to select the sample size (respondents), who are registered rice farmers that participated in the ATA programme in each of the villages. The list of the beneficiary registered rice farmers that participated in the programme was obtained from the Federal Ministry of Agriculture and Rural Development (FMARD) office in the State (Green House). This lists served as the frame from which the samples were drawn. Using the proportionate to size sampling technique, a total of 97 rice farmers that benefited in the ATA programme were randomly selected from the farming communities in the LGAs and interviewed.

Similarly, another 97 non-beneficiary rice farmers from these areas were randomly sampled proportionately from the neighbouring communities to serve as a control. This is to avoid location bias and spillover effect of the programme if the control were to be selected from same communities as the beneficiaries. This brought the total number of the respondents to 194.

Data Collection

Data for this study were elicited from primary sources. The primary data was obtained from field surveys using structured questionnaire and this was complimented with the use of interview schedules for the non-literate respondents. Data collected for the study include farm size, farm output per annum, income from sales, type and quantity of seeds accessed in the ATA programme as planting material, price per kg of seeds purchased, type and quantity of fertilizer accessed in the ATA, price per kg of fertilizer purchased, type and quantity of herbicides accessed in the ATA, number of years of access to the programme, access to the commercial banks and microfinance banks credits through NIRSAL agricultural credit guarantee scheme; amount, tenor and interest rates of NIRSAL loans collected; total labour used which include family and hired labour, etc. These data were on the farming activities of the respondents between the 2012 and 2015 cropping season when there was the full implementation of the ATA.

Analytical Techniques

The determinants of access to the Agricultural Transformation Agenda (ATA) programme was achieved using the Logit regression model. Total Factor Productivity (TFP) and Partial Factor productivity (PFP) Indexes were used to determine the effects of the ATA programme on the productivity of the rice farmers in the study area.

Logit Regression Model

The Logit Regression Model was used to estimate the determinants of access to the Agricultural Transformation Agenda programme by rice farmers in the Niger State of Nigeria.

The implicit form of the model is specified as follow:

$$I_i^* = \alpha + \delta X_i + \varepsilon_i \quad (1)$$

Where I_i^* represents a latent variable which is assumed to be normally distributed i.e $\varepsilon \sim N(0, \delta^2)$ but I_i is not. X_i represents rice farmer's attributes. I_i denotes the observable value, which takes on the value of 1 or 0. In this study, $I = 1$ for farmers who participated in the ATA programme, while $I = 0$ for the farmers who did not participate.

$$I_i = \{1 \text{ if } I_i^* > 0$$

$$= \{0 \text{ if } I_i^* \leq 0$$

Explicitly, the model is specified as:

$$Y = \alpha_0 + \alpha_1 EDU + \alpha_2 AGE + \alpha_3 SIZ + \alpha_4 COOP + \alpha_5 EXP + \alpha_6 EXT + \alpha_7 POL + \alpha_8 DIST + \alpha_9 DIV$$
$$\alpha_{10} TIME + \alpha_{11} LOAN + \alpha_{12} COLL + \varepsilon \quad (2)$$

Where Y is the dichotomous dependent variable which can be explained as; Y=1, if the farmer has access to the ATA programme and 0 if otherwise.

The X's are the independent variables which are defined as follows:

EDU = Educational level (measured by the number of years in receiving formal education); AGE = Age of the farmer (in years); SIZ = Farm Size of the farmer (in hectares); COOP = Membership of Cooperative Society or farmer's group (Dummy, 1 = if the farmer is a member, 0 = if non-member); EXP = Years of Farming Experience (Number of years spent in the farming business measured in years); EXT = Extension Contact (Number of contact with extension service in a cropping season); POL = Political Interference (1 = If there were incidence of political actors who influenced/hijacked/interfered with the programme, 0 if otherwise); DIST = Distance to ATA Programme Site (Distance of farmer's residence to programme site measured in Km); DIV = Diversion of the inputs by the vendors (1 = if there were cases of diversion of the farm inputs by the vendors, 0 = if otherwise); TIME = Timely distribution of inputs at redemption centers (1 = if the inputs were distributed before planting, 0 = if otherwise); LOAN = Access to loan facilities (Amount of loan facilities measured in ₦); COLL = Collateral (Defined as valuable assets that eases access to the programme; 1 = have valuable assets, 0 = otherwise), and ε = error term.

Total Factor Productivity

The Total and Partial Factor Productivities were used to determine the productivities of the rice farmers in the study area. O'Donnell (2008), Sabasi and Kompaniyets (2015) showed that Total Factor Productivity (TFP) for a farmer *i* in period *t* can be expressed mathematically as:

$$TFP_{it} = \frac{Y_{it}}{X_{it}} \quad (3)$$

Where $Y_{it} \equiv Y(y_{it})$ is aggregate output, $y_{it} \epsilon\, i_+^M$ is a vector of output quantities, $X_{it} \equiv X(x_{it})$ is aggregate input, and $x_{it} \epsilon\, i_+^N$ is a vector of input quantities.

Ojo, *et al.* (2018) and Emenyonu, *et al.* (2014) in like manner expressed Total Factor Productivity as:

$$\text{Total Factor Productivity (TFP)} = \frac{\text{VOP}}{\text{VIE}} \quad (4)$$

Where, TFP = Total Factor Productivity

VOP = Value of Output Produced (₦)

VIE = Value of Inputs Employed (₦).

The effect of ATA on the productivity of the farmers was determined using the following regression model:

$$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8 + e_i) \quad (5)$$

Where;

Y = Total factor productivity index,

X_1 = Farm Size (Ha), X_2 = Labour used (man-days), X_3 = Fertilizer applied in (Kg), X_4 = Seed used in (Kg), X_5 = Agrochemical applied in (liters), X_6 = NIRSAL Credit/Loan collected in (₦), X_7 = Farmer registration in National farmer's Database (1 if registered, 0 if otherwise), X_8 = ATA participation (1 if participated, 0 if otherwise).

The explicit forms of the functional forms fitted to the data are:

Linear Form:

$$Y = \beta_0 + \beta_1X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + e \qquad (6)$$

Exponential form:

$$\ln Y = \beta_0 + \beta_1X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + e \qquad (7)$$

Semi-Log Form:

$$Y = \beta_0 + \beta_1\ln X_1 + \beta_2\ln X_2 + \beta_3\ln X_3 + \beta_4\ln X_4 + \beta_5\ln X_5 + \beta_6\ln X_6 + \beta_7\ln X_7 + \beta_8\ln X_8 + e \qquad (8)$$

Double-log Form:

$$\ln Y = \beta_0 + \beta_1\ln X_1 + \beta_2\ln X_2 + \beta_3\ln X_3 + \beta_4\ln X_4 + \beta_5\ln X_5 + \beta_6\ln X_6 + \beta_7\ln X_7 + \beta_8\ln X_8 + e \qquad (9)$$

β_0 = Intercept

$\beta_1 – \beta_8$ = Parameters to be estimated

Y and X_i are as earlier defined.

The Partial Factor Productivities was also be used to estimate the productivity of the farmers in the different inputs employed in rice production in the study area. The different input factor productivities otherwise referred to as partial factor productivities are estimated as with the example below:

Land Partial Factor Productivity

The Land Factor Productivity is estimated as:

$$\text{Land Productivity} = \frac{\text{Quantity of Output Produced (Kg)}}{\textit{Total Land Employed (Ha)}} \qquad (10)$$

The partial productivities of other factors such as labour productivity, seed productivity, fertilizer productivity and agrochemical productivity were also estimated in like manner as above.

RESULTS AND DISCUSSIONS

Determinants of farmer’s access to the ATA/GES programme

The result of the logit regression of the determinants of the rice farmer’s access to the Agricultural Transformation Agenda (ATA) programme is shown in Table 1 and this result shows that farm size and membership of cooperative society were directly related to access to the ATA programme and significant 1% level of probability. Level of education, age and number of extension contacts in a year of the rice farmers were also directly related to access to the ATA programme and significant at 5% level of probability. This indicates that a unit increase in these variables holding other factors constant led to an increase in the probability of rice farmer’s access to the ATA programme by 0.287, 0.332, 0.670, 0.886 and 0.951 times respectively. This implies that there is significant contribution of these factors to rice farmer’s access to the ATA programme in the study area. This result is consistent with the findings of Agbarevo and Ukagha (2018) that farms size and farmer’s membership of cooperative were among the key determinants of farmer's participation in the E-wallet/Growth Enhancement Scheme agricultural input delivery system in Nigeria.

The result however, further shows that distance to the ATA programme site is inversely related to farmer's access to the programme and significant at 1% level of probability. This implies that the farther the ATA programme site to the farmer, the less likely the farmer is to accessing the programme.

Table 1: Logit regression results of determinants of farmer's access to the ATA programme.

Variables (n=194)	Coefficients	t-value	Sig.
Level of Education	0.287	0.72**	0.047
Age	0.332	2.27**	0.023
Farm Size	0.670	2.81***	0.005
Membership of Cooperative Society	0.886	3.65***	0.000
Farming Experience	0.197	1.29	0.198
Number of Extension Contacts	0.951	2.09**	0.037
Political Interference	-0.198	-0.82	0.409
Distance to ATA Programme Site	-0.520	-4.83***	0.001
Diversion of Inputs by Vendor	0.556	0.25	0.799
Timely distribution of inputs	0.366	-0.27*	0.078
Access to Loan	0.001	0.87	0.384
Ownership of Collateral	-0.383	-0.71	0.476
Constant	2.644	-4.10***	0.000

*** = Significant at 1% level of probability, ** = Significant at 5% level of probability,
* = Significant at 10% level of probability.

Source: Field Survey, 2019.

Summary statistics of Partial Factor Productivity of rice farmers in Niger State, Nigeria

The results of the partial productivity indices of inputs such as fertilizer, seed, land, labour and agrochemical are presented in Table 2. The results reveal that the mean partial productivity of fertilizer for the beneficiaries of the ATA programme is 15.18kg/ha while that of the non-beneficiaries was 11.95kg/ha and the difference was statistically significant ($p<0.01$). Also the mean partial productivities of improved seeds, land, labour and agrochemicals for the beneficiaries were also found to be greater than that of the non-beneficiaries and they were also statistically significant. The difference in the partial productivities could be attributed to the effect of participation in the ATA programme which provided the beneficiaries with more inputs of fertilizer, improved seeds, agrochemicals and credits which made them to be able to cultivate more land space and utilized more labour. This also agrees with the findings of Ojo *et al.* (2018), Obasi *et al.* (2013) and Fakayode *et al.* (2007).

Table 2: The summary statistics of partial factor productivities of rice farmers In Niger State, Nigeria

Variable	Beneficiaries (n=97)				Non-beneficiaries (n=97)				
	Mean	Standard Deviation	Min.	Max.	Mean	Standard Deviation	Min.	Max.	t-value
Fertilizer (Kg)	15.18	9.62	13.24	17.12	11.95	7.23	10.50	13.41	-2.6403***
Improved Seed (Kg)	49.93	28.95	44.10	55.77	39.97	27.57	34.41	45.52	-2.455***
Land (Ha)	20.21	9.29	18.34	20.09	17.17	11.95	15.56	20.37	-1.4605***
Labour (Mandays)	6.22	2.25	5.77	6.68	4.76	1.96	4.37	5.16	-4.8248***
Agrochem (liters)	97.95	71.70	83.50	112.40	52.07	86.53	44.54	59.59	-12.7961*

*** = Significant at 1% level of probability, ** = Significant at 5% level of probability, * = Significant at 10% level of probability.

Source: Field Survey, 2019.

Effects of Agricultural Transformation Agenda (ATA) on productivity of rice farmers in Niger State, Nigeria.

The Total Factor Productivity (TFP) Index was used to estimate the effect of the ATA programme on the productivities of the rice farmers in the study area. Table 3 shows the results of the effect of the ATA programme on the total productivity of the rice farmers in the study area using the TFP. The results shows that the model has an F-ratio of 32.52 and that the whole model is statistically significant at 1% level of probability. The coefficient of determination (R^2) indicated that 34.2% variations in the productivity of the rice farmers in the study area were explained by the explanatory variables included in the model.

The Table 3 further revealed that farm size, labour used, quantity of fertilizer applied, amount of improved seed used, quantity of agrochemicals used, amount of NIRSAL loans collected and ATA participation were all directly related to productivity and are all significant at 1% level of probability. This indicates that a unit increase in these variables holding other factors constant led to increase in the productivity of the rice farmers by 0.190, 0.166, 0.975, 0.299, 0.866, 0.206 and 0.457 respectively. This finding is corroborated with the findings of Ojo, *et al.* (2018), Obasi *et al.* (2013) and Fakayode *et al.* (2007) who reported that farm size, labour used, fertilizer use and planting material are among the main factors that determines farm productivity. Also findings by Anyanwu (2014) confirms that agricultural credits/loans in form of microcredits are one of the major determinants of farm productivity and has significant effects on it.

Conversely, farmer registration in the National Farmer's Database was found to be indirectly related to productivity and was statistically significant at 1% level of probability.

Table 3: Effect of the Agricultural Transformation Agenda programme on the productivity of rice farmers in Niger State, Nigeria (double-log as the lead equation)

Variables (n=194)	Coefficients	t-value
Farm Size, X_1 (Ha)	0.190	5.66***
Labour used, X_2 (Man-days)	0.166	3.04***
Fertilizer applied, X_3 (Kg)	0.975	5.83***
Amount of Seed used, X_4 (Kg)	0.299	4.49***
Agrochemicals Applied, X_5 (liters)	0.866	3.70***
Amount of NIRSAL Loan collected, X_6 (₦)	0.206	5.24***
Farmers Registration in National Farmer's Database, X_7 (Dummy, Yes=1, No=0)	-0.003	-0.22
ATA Participation, X_8 (Dummy, Yes=1, No=0)	0.457	3.97***
Constant	-2.088	-6.09
R^2 Square	0.342	
Adjusted R^2 Square	0.331	
F-Ratio	32.52***	

*** = Significant at 1% level of probability, ** = Significant at 5% level of probability, * = Significant at 10% level of probability.

Source: Field Survey, 2019.

CONCLUSION AND RECOMMENDATIONS

The results of the Logit regression model used to evaluate the determinants of access to the ATA shows that farmer's farm size and membership of cooperative society were directly related to access to the ATA programme and significant 1% level of probability. Level of education, age and number of extension contacts in a year of the rice farmers were also directly related to access to the ATA programme and significant at 5% level of probability. The result of the TFP Index used to estimate the effect of the ATA programme on the productivities of the rice farmers in the study area shows that farm size, labour used, quantity of fertilizer applied, amount of improved seed used, quantity of agrochemicals used, amount of NIRSAL loans collected and ATA participation were all directly related to productivity and are all significant at 1% level of probability. Specifically, the study shows that a unit increase in these variables holding other factors constant led to increase in the productivity of the rice farmers by 0.190, 0.166, 0.975, 0.299, 0.866, 0.206 and 0.457 times respectively. The study recommends that since the programme showed significant increases in the productivity of the beneficiaries when compared with the non-beneficiaries, government policies, investments and efforts in the agricultural sector would build on the successes of the ATA programme while improving on the identified pitfalls or weaknesses to be able to stimulate further increases in the growth and productivity of farmers particularly in rice subsector.

REFERENCES

African Development Bank (AfDB, 2013). Strategic Environmental and Social Assessment of Agricultural Transformation Agenda Support Programme – Phase 1 in Nigeria (Executive Summary). Africa Development Bank Group. Pp 3-9.

Agbarevo, M. N. & Ukagha, O. (2018). Determinants of Participation of Farmer in the E-wallet Agricultural Input Delivery System in Abia State, Nigeria. *Journal of Agricultural Extension*, 22(3): 109–116.

Anyanwu, I. B. (2014) Evaluation of the effects of microfinance credit scheme on poverty alleviation among small-holder farmers in Niger State, Nigeria. An unpublished Thesis presented to the Postgraduate School, Federal University of Technology, Minna in partial fulfillment of the Requirements for the award of the Master of Technology (M.Tech) in Agricultural Economics. Pp 65 – 70.

Emenyonu, C. A., Nwosu, A. C., Lemchi, J. I. & Iheke, O. R. (2014). Analysis of Productivity, Profitability, Income and Returns on Investments in Youth SMEs in Niger Delta, Nigeria. *International Journal of Small Business and Entrepreneurship Research.* 2 (1): 20-34.

Fakayode, S. B., Babatunde, R. O. & Ajao, R. (2007). Productivity Analysis of Cassava-Based Production Systems in the Guinea Savannah: Case Study of Kwara State, Nigeria. *American-Eurasian Journal of Scientific Research*, 3(1):39.

Federal Ministry of Agriculture and Rural Development, FMARD (2011) Agricultural Transformation Agenda: We will grow Nigeria's Agricultural Sector. Abuja, FMARD. Pp 12-70.

Kolawole, O., & Ojo, S. O. (2007). Economic Efficiency of Small-Scale Food production in Nigeria. *Journal of Social Sciences*, 14(2): 123–130.

Muhammad-Lawal, A. & Omotesho, O. A. (2008) Cereals and Farming Households' Food Security in Kwara State, Nigeria. *Agricultural Journal*, 3(3): 235 – 240.

National Population Commission, NPC (2009). 2006 National Population Census Official Gazette (Extraordinary). 94 (4): 52.

Obasi, P. C., Henri-Ukoha, A., Ukewuihe, I. S., & Chidiebere-Mark, N. M. (2013). Factors affecting agricultural productivity among arable crop farmers in Imo State, Nigeria. *Nigerian American Journal of Experimental Agriculture*, 3(2): 443-454.

Ojo, M. A., Usman M. A., Mohammed U. S., Ojo A. O. & Oseghale, A. I. (2018). Effect of Insurgency on Food Crop farmers' Productivity in Borno and Gombe States, Nigeria. *Ife Journal of Agriculture*, 3(30): 43-55.

O'Donnell, C. J. (2008). An Aggregate Quantity Price Framework for Measuring and Decomposing Productivity and Profitability Change. Center for Efficiency and Productivity Analysis Working Paper No. WP07/2008, University of Queensland. Retrieved May 10, 2016 from http://www.uq.edu.au/economics/cepa/docs/WP/WP072008.pdf

Sabasi, D. & Kompaniyets, L (2015). Impact of Credit Constraints on Profitability and Productivity in U.S Agriculture. Selected Paper Prepared for presentation at the

Agricultural & Applied Economics Association's 2015 AAEA Annual Meeting, San Francisco, California, CA, July 26-28 2015. Pp 6-12.

29 A REVIEW ON THE EFFECTS OF ADOPTION OF CLIMATE-SMARTS AGRICULTURAL (C S A) PRACTICES ON THE PRODUCTIVITY OF RICE FARMERS IN KWARA AND NIGER STATE, NIGERIA

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Abstract

This paper is a review of effects of the adoption of Climate- Smart Agricultural (CSA) practices on the Productivity of Rice Farmers in Kwara and Niger State; Nigeria. There have been many Climate- Smart Agricultural Practices that influenced the adoption and the intensity of the use of climate-smart Agricultural practices which includes crop rotation, diversification, improved crop varieties, integration of legumes into cropping system, green manure, compost, Irrigation and Bunds among many. The adoption of Climate-Smart Agricultural(C S A) practices could assist to ensure food sufficiency despite unsuitable climate condition (Tiamiyu et al., 2018). The findings of the majority of the literature reviewed, point to the fact that effects of adoption of climate- smart Agricultural practices is exclusive to a particular technology. There are number of constraints associated with the adoption of climate- smart Agricultural practices in Rice production. Some of the constraints are lack of credit facilities, poor extension services delivery, Increase in the price of Agricultural inputs and Irrigation facilities. It is apparent that the adoption of climate- smart Agricultural practices can lead to increase in rice productivity thereby, improve Farmers' income and their living standard.

Key words: Effects; Adoption; Climate-Smart; Practices; Productivity.

INTRODUCTION;

The economy of sub-Saharan African (SSA) countries is mostly dependent on agricultural production (Apata *et al.*, 2009). Increasing productivity in agriculture depend largely on a number of factors, including weather and climate conditions. Climate change through extreme weather condition has become recurrent subject of argument globally and Nigeria is one of the countries among many others contributing to global warming. Climate change as put forward by United Nation Framework Convention on Climate Change is "attributed directly or indirectly to human activities that changes the composition of the entire Global atmosphere which is, in addition to natural climate variability observed over comparable periods"(UNFCCC, 2015). Climate change pose a significant challenge bordering agricultural productivity of Rice in Africa and Nigeria in particular. It makes the entire African region vulnerable continent to the current climate variability with serious economy impacts especially to agricultural production, and a threat to food security. Climate Smart Agricultural (C S A) is defined as an approach that promotes sustainable increase in agricultural productivity and income and building resilience to climate change and reducing Greenhouse Gas Emissions (GHGE). It includes crop rotation, diversification, improved varieties, integration of legumes into cropping system, green manure, compost, Irrigation and Bunds among many. The adoption of Climate-Smart Agricultural(C S A) practices could assist to ensure food sufficiency despite unsuitable climate condition (Tiamiyu *et al.*, 2018). This can also be achieved through several soil management practices that separate carbon in the soil, reduce Greenhouse Gas Emission and aids intensifying production (FAO., 2013).The most important premise of CSA is the building of healthy soil through increasing soil organic matter status. Climate- smart agriculture (CSA) has been presented as an alternative form of agricultural production for sustainable increase in agricultural productivity and income of the Farmers. Its help enhances adaptation and building resilience to the challenges pose by climate change, thereby enhancing national food security and sustainability. Climate- smart- agriculture provide adaptation strategies that can help avoid the negative impacts of climate change on crops and livestock production, incomes and well- being of smallholder farmers (F A O., 2013).

Adaptation to Climate Change in Agriculture

Intergovernmental panel on climate change (IPCC) defines climate change adaptation as “adjustment in human and natural systems in response to actual or expected climatic variation, with a view to moderating harm or exploiting beneficial opportunities” (IPCC, 2007). Adaptation in agriculture has increasingly gained attention with its application taking different dimensions such as transformation of whole farming systems, modifications of existing systems and adoption of practices such as soil and water conservation, agro-forestry (Ifejika, 2010; Meridian Institute, 2011).

Climate Smart Practices

Efforts towards addressing climate change effects in agriculture and particularly among small scale farmers, have often been seeking for innovation and improved access to technological practices (Howden *et al.*, 2007). There have been several efforts towards adoption of best practices for adapting to the effects of climate change (Beddington *et al.*, 2011).The approach is based on the acronym SMART, where S stands for specific, M for measurable, A for achievable, R for reliable and T for timely (Carthy *et al.*, 2012). The climate smart approach aims at enhancing productivity and returns, improving adaptation of livelihoods and ecosystems and reducing greenhouse gas emissions (FAO, 2010). In the light of the climate smart concept, agriculture is therefore considered SMART if it meets the above indicated objectives.

The approach includes well proven technologies that already exist and other innovative practices such as; conservation agriculture; agro-forestry; water harvesting and efficient use; use of varieties and breeds that can perform better under various climatic stresses; use of safety nets, risk insurance and timely climate information by farmers (FAO, 2010).

Adoption of Climate Smart Practices among Small Scale Farmers

Adoption of scientific and technological innovations in the agricultural sector has received considerable attention given their contribution to improved productivity and incomes (Branca *et al.*, 2012), particularly in the developing countries, where agriculture play a vital role in terms of eradicating poverty, hunger and supporting livelihoods of the majority of small scale farmers (World Bank, 2008). As such numerous agricultural technologies have been developed besides the vast literature generated. In spite of these efforts, adoption of new technologies at farm level remains a challenging and a dynamic issue.

Factors Influencing Adoption of Climate Smart Practices among Small Scale Farmers

The adoption of technologies has been shown to depend upon many factors including household and farm characteristics. According to Jones *et al* (2010), a numbers of factors affect adoption of C S A. These includes, age, gender, level of education, farm size and farming experience. Other factors that influence decision with regard to adoption comprise perception of the problem, characteristics of technologies, institutions and the influence of the market (Jones *et al.*, 2010).

Assets and wealth endowment such as income, savings and access to credit, and insurance is considered to have significant influence on adoption of technologies by small scale farmers. This is because they act as a 'safety net' in time of crisis, enabling farmers to innovate, and take risks, which support long-term sustainable adaptation (Jones *et al.*, 2010).

Effect of Climate- smart Agricultural Practices on Productivity of Rice Farmers.

A number of studies have been carried out to assess adoption of climate-smart agricultural practices and its benefits to Rice productivity when a farmer adopt Climate-smart agricultural practices and continue to use or applying them in their farm operation. There some evidences to the fact that adoption of Climate-smart agricultural practices could increase the yield of Rice farmers and can help to maintain soil management practices that separate carbon in the soil, reduce Greenhouse Gas Emission and aid in production. According to Isaac (2013), considered Agricultural practices as more profitable compared to conventional practices. Such practice includes green manure, organic manure, refuse retention, crop rotation, use of chemical fertilizer and pesticides. The high perceived profitability is likely to boost adoption of climate- smart practices among Rice farmers.

Table 1: Adoption of CSAPs by Rice farmers

Variable	Mean	Standard deviation
Green manure	0.17	0.34
Agro-forestry	0.42	0.44
Organic manure	0.43	0.42
Refuse retention	0.45	0.43
Crop rotation	0.29	0.41
Zero/minimum tillage	0.37	0.41

Source: Field work Funminiyi *et al*., (2020).

Conclusion and Recommendation:

Many factors have been identified to influence adoption and intensity of adoption of agricultural technologies, Household size and farm characteristic which include Age, gender, level of Education, Farm size and farming experiences. There are number of constraint associated with adoption of climate- smart agriculture practices, social cultural practices, customs, beliefs and values, land tenure system, inadequate access to credits facilities and sources of information. The study recommends improved extension linkages to sensitize small- scale Farmers on the need to adopt climate-smart agricultural practices, Rice Farmers need to be educated more on the climate-smart agricultural practices benefits associated with the uses and supply of information and credit to Rice Farmers must be timely so that farmers can make good use of it.

REFERANCES

Apata T. G:, Samuel, K. D, & Adeola, A. O. (2009). Analysis of climate change perception and adaptation among arable food crop farmers in South Western Nigeria. Journal of Science and technology education research 1 (4), 85-91.

Beddington, J., Asaduzzaman, M., Fernandez, A., Marrion G., Erda, L., *et al.* (2011). *Achieving Food Security in the Face of Climate Change:* Summary for Policy Makers from The Commission on Sustainable Agriculture and Climate Change. copenhagen, Denmark: CGIAR Research program on Climate Change, Agriculture and Food Security.

Branca, B., Tennigkeit, T., Mann, W., & Lipper, L. (2012). Identifying Opportunities for Climate-Smart Agriculture Investments in Africa". A study for FAO program of work on Economics and Policy Innovations for Climate-smart Agriculture (http://www.fao.org/climatechange/climatesmart/en/. Rome: FAO.

FAO. (2010). Climate Smart Agriculture Policies, Practices and Financing for Food Security Adaptation and Mitigation United Nations. Rome Italy: Food and Agriculture Organization.

FAO. (2013). Climate Smart Agriculture Source Book. United Nations . Rome, Italy: Food and Agriculture Organization.

Howden, S., Soussana, J., Tubiello, F., Chhetri, N., Dunlop, M., & Meinke, H. (2007). Adapting Agriculture to climate change. Retrieved August 2, 2022. From http:/www.pnas.org/ content/104/50/19691.

Ifejika, S. (2010). *Resilient Adaptation to Climate Change in African Agriculture.* Bonn, Germany: Deutsches Institut fur Entwicklungspolitik/German Development Institute.

IPCC. (2007). *Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge, UK: Cambridge University press.

Jones, L., Lundi, E., & Levine, S. (2010). *Towards a Characterization of Adaptive Capacity: A Framework for Analyzing Adaptive Capacity at the Local Level.* Overseas Development Institute, UK.

Meridian Institute . (2011). *Agriculture and Cimate change: a Scoping Study.* Meridian Institute. Washington, DC, USA: Meridian Institute.

Tiamiyu, S. A:, Ugalahi, U. B:, Fabunmi, T:, Sanusi, O. R:, Fapojuwo,O.E, & Shittu, M. A. (2017) Analysis of farmers adoption of Climate Smart Agricultural Practices in Northern Nigeria, Proceeding of 4th *"Agriculture and Forestry in Nigeria"* (Samih, A; Prof. D.K.N.G; and Pushpakumara. 19-26

UNFCCC (2015). Resource guide for preparing the national communications of non-annex 1 parties. Module 2 vulnerability and adaptation to climate change.http//unfccc.Int/2679/Accessed on 4th February 2022.

World Bank. (2008). *World Development Report 2008: Agriculture for Development.* Washington, DC: The World Bank.

30 ANALYSIS OF DETERMINANTS OF MARKET PARTICIPATION AMONG LOCAL RICE FARMERS IN SELECTED LOCAL GOVERNMENT AREAS OF NIGER STATE, NIGERIA

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Abstract

Improving the welfare of small-scale farmers is hinged on their access to markets and active engagement in the markets. The main objectives of this research were to analyze the determinants of decision to participate and level of market participation as well as the constraints militating against market participation among rice farmers in the study area. Muti-stage sampling technique was used to sample 100 farmers for the study. Cross-sectional data were collected using semi-structured questionnaire to elicit relevant information from the farmers. The analytical techniques involved descriptive statistics and probit and truncated regression models. The findings revealed that age, education, plot devoted to rice cultivation and household size were the major determinants of decision to participate while extension services, market type, gender of the farmer, household size and transportation cost were the major determinants of level (intensity) of market participation. The main constraints to market participation among rice farmers were infrastructural deficit, high cost of transportation, unavailability of farmland and absence of government support for marketing. Based on the findings of this research, it is therefore recommended that government should address the infrastructural deficit in term of existing road rehabilitation and construction of new roads to make market accessible to the rice farmers.

Keywords: *Market, farmers, participation, Rice, Nigeria*

INTRODUCTION

Nigeria is the most populous country in Africa with 70.8 million hectares of agriculture land area and which has rice, maize, cassava, guinea corn, yam, cowpea and millet as the major crops grown (Tsokar, 2021). In 2020, Nigeria's GDP amounted to 152.32 trillion Naira which translates to over 400 billion U.S dollars out of which agriculture contributed about 24.41% of this amount (O'Neill, 2021). Hence, it is a key activity for Nigeria's economy after oil as it provides livelihood for many Nigerians. Recent poverty statistics of the country revealed that 39.1% of Nigerians lived below the international poverty line of $1.90 per person per day in 2018/19 and that a further 31.9% percent had consumption levels between $1.90 and $3.20 per person per day, making them vulnerable to falling into extreme poverty when shocks occur. (World Bank, 2021). The monthly COVID-19 National Longitudinal Phone Survey (NLPS) revealed that, the impact of Covid -19 pandemic coupled with high inflation for key food items has led to increasing food insecurity, especially for poor households. Given this rise in food insecurity, alongside school closures and displaced health services, the crisis may have negative long-term effects on the households capital formation (World Bank, 2021). Participation of these households in agricultural markets is therefore expected to improve their welfare outcomes (Muricho *et al*., 2015 and Holloway *et al.*, 2005). This expectation has made governments in most of the developing countries like Nigeria to promote policies aimed at ensuring overall commercialization of smallholder agriculture (Macharia *et al*., 2014; Muricho *et al.,* 2015). These will increase the ability of smallholder farmers to participate in markets either as output sellers and input buyers. For instance, the recent ban on rice imports coupled with increase in population growth in Nigeria has led to increased demand and consumption of locally produced rice. This presents new and expanding market opportunities for smallholder rice farmers both in Niger State and other parts of the country. Despite the laudable importance of marketing in improving the livelihood of the farmers, participation in agricultural markets has been hampered by infrastructural deficit, poor road network and marketing risks. This has induced high transaction costs thereby reducing market participation by the rice farmers. In line with this assertion, Holloway *et al*. (2005) emphasized that inappropriate policies and misallocation of investment resources could skew the distribution of the benefits and opportunities away from the smallholders who would potentially gain the most from these market opportunities. Lapar *et al*. (2003) also posited that the inability of smallholder producers to take advantage of economies of scale in production and marketing is a significant impediment to market participation. Besides, remoteness from towns and low population density could also be a threat. All these may result to fallout in subsistence rather than market-oriented production systems. It is against these backdrops that this study attempts to add to the existing body of knowledge on the determinants of both decision to market participation and level of market participation among rice farmers as well as the constraints militating against market participation in the study area.

METHODOLOGY

Area of Study

This study was carried out in Niger State, Nigeria. The State is situated at lattitude 8˚22ˈN and 11˚30ˈN and longitude and 70˚20ˈE. The State has the largest land mass of 74,244 square kilometres or about 8% of the total land mass in Nigeria It has a total of 25 LGAs. Its population is 3,954,772, comprising 2,004,350 males and 1,950,422 females (Federal Republic of Nigeria (FRN), 2009) which was projected to 5,556,200 (United Nations Population Fund (UNFPA), 2016). The State is divided into three agricultural Zones. It has a seasonal variation from wet to dry season wherein the wet season falls within April to October while the dry season falls within November-March. The average temperature and annual rain fall distribution are 27˚C and 1000mm-1500mm annually.

Sampling Technique and Sampling Size

A multi-stage sampling procedure was used to select respondents for this study. In the first stage, 2 LGAs were randomly selected for the study. The second stage entailed random selection of 2 town/villages from each of the selected LGAs while in the third stage, 25 farmers were selected from each of the 2 randomly selected town/villages which gave a total sample size of 100

Method of Data collection

Primary data were collected using semi-structured questionnaire and interview schedules. Information on level of participation in rice marketing and constraints were collected.

Analytical Techniques

Analysis of the level of market participation was achieved using the Double Hurdle model following the work of Abu (2013) and Mignouna *et al*. (2016). The DH model is a parametric generalisation of Tobit model in which two separate stochastic processes determine the decision to participate and level of participation. The decision to participate or not to participate in marketing usually precedes the level of participation though empirical evidence has proved that it can either be done simultaneously or independently or sequentially. But for the purpose of this study, the latter will be assumed. The model is based on an assumption that these two separate hurdles or stages must occur before a positive level of market participation is observed. The DH model is estimated by the Probit and the Truncated regression models respectively. In the first stage of the analysis,

$y_t=1$ If > 0

$y_t = 1$ If < 0

$$y_i* = X_i^1 \alpha + \varepsilon_i$$

Where,

y_i* = Latent participation variable that takes on the value of 1

X_i = Vector of household characteristics

α = Vector of parameter

In the second stage, the level of participation is represented thus,

$$t_i = t_i^* > 0; y_i^* > 0$$

$t_i = 0$ otherwise

$$t_i* = Z_i^1 \beta + u_i$$

Where,

t_i = Observed response on the quantity of rice to be conveyed to the market

Z_i = Vector of household characteristics

β = Vector of parameter

The Probit model was used to determine the probability of participation in the market. The procedure for analyzing the Probit model start with identifying the dependent variable, which is a dummy and can assume only two values (either 0 or 1). The Probit model is specified thus:

$$P_{(sy-1)} = f(z_i) = \frac{1}{\sqrt{2\pi}} \sum_{\infty}^{z_i} \frac{\ell u^2 du}{2}$$

Where the unobservable z_i is a linear combination of the observable explanatory variables. The model explanatory variables are specified thus;

Y = Decision to participation or not to participate (Participation = 1; 0 otherwise)

X_1 = Age of farmer (Years)

X_2 = Family size of farmer (No.)

X_3 = Level of education (Years of schooling)

X_4 = Farmer' years of experience in marketing (Years)

X_5 = Distance to market (Km)

X_6 = Plot devoted to rice cultivation (Ha)

X_7 = Access to credit facilities (₦)

X_8 = Membership of social group (Member = 1; 0 otherwise)

X_9 = Type of labour (Family labour = 1; 0 otherwise)

X_{10} = Ownership of means of transportation (Yes =1; 0 otherwise)

X_{11} = Transportation cost (₦)

The second hurdle is the level of participation and is explicitly expressed thus:

Y = Level of participation (Quantity of rice sold in kg)

X_1 = Waiting time before sale of rice is made at the market (Hours)

X_2 = Transport fare of 100kg of rice from farm to market (Naira)

X_3 = Age of farmer (Years)

X_4 = Gender of farmer (Male = 1; 0 otherwise)

X_5 = Marital Status of farmer (Married = 1; 0 otherwise)

X_6 = Family size of farmer (No.)

X_7 = Level of education (Years of schooling)

X_8 = Farmer's marketing experience (Years)

X_9 = Membership of social group (Member = 1; 0 otherwise)

X_{10} = Total annual income of household (₦)

X_{11} = Access to market information (Access =1; 0 otherwise)

X_{12} = Market type (Local =1; 0 otherwise)

X_{13} = Ownership of means of transportation (Yes =1; 0 otherwise)

X_{14} = Access to credit facilities (₦)

X_{15} = Extension services (No.)

X_{16} = Farm size (Ha)

RESULTS AND DISCUSSION

Factors Affecting the Decision to Participation

The result of the Probit regression used in the determination of the factors affecting the decision to participate was as shown in Table 1. The log likelihood result indicated how quickly the model converged while the likelihood ratio chi-square of 40.23 showed that the whole model was statistically significant at $P > 0.01$. The result further revealed that some of the exogenous variables were positive and statistically significant at different probability levels that is, age at $P > 0.05$, level of education at $P > 0.10$ and plot devoted to rice cultivation at $P > 0.10$. Household size, however was negative but significant at $P > 0.01$. However, since probit is a probability model, it will be better to interpret the result using the marginal effect and elasticity as shown in Table 2.

Table 1: Determinants of decision for market participation among rice farmers in the study area

Variables	Coefficient	Z values	P > | t |
Age	0.0554	2.23**	0.026
Household size	-0.1400	-3.08***	0.002
Level of education	0.0726	1.93*	0.054
Years in farming	0.0258	1.03	0.305
Distance to market	-0.0405	-0.79	0.430
Plot devoted to rice	0.5111	1.91*	0.056
Access to credit	-0.6716	-1.23	0.218
Farmers association	-0.3691	-0.92	0.356
Type of labour	0.5412	1.26	0.208
Ownership of means transportation	0.8682	1.24	0.213
Transportation fare	-0.0003	-1.16	0.245
Constant	-2.7151	-1.80*	0.072

LR chi^2 = 40.23, Prob > chi^2 = 0.000, Pseudo R^2 =0.3471, ***significant at 1%, **significant at 5%, *significant at 10 %

Marginal effect and partial/quasi elasticity: Analysis of marginal effect and partial elasticity was carried out on the significant variables of determinants of decision for market participation among rice farmers in the study area (Table 2). The result of the marginal effect showed that one percent increase in age, level of education and plot devoted to rice production led to 0.0096, 0.0138 and 0.1061 percent increase in the probability of the rice farmer's participation in the market. Conversely, one percent increase in household size of farmers led to 0.0324 decrease in the probability of the rice farmers' participation in the market. The result of the partial elasticity of the significant variables revealed that age, level of education and plot devoted farm size were inelastic, *that is*, a one percent unit change in any of these explanatory variables led to a less than proportionate change in the probability of rice farmers' participation in the market. On the contrary, the partial elasticity of household size was elastic, *that is*, a one percent unit change in household size led to a more than proportionate change in the probability of rice farmers' participation in the market.

Table 2: Marginal effects and quasi elasticity

Variables	Marginal effect	Elasticity
Age	0.0096	0.8630
Household size	-0.0324	-1.0008
Level of education	0.0138	0.1670
Plot devoted to rice production	0.1061	0.5232

Determinants of Farmers' Level of Market Participation

Table 3 showed the result of level of market participation using ordinary regression analysis. The linear regression result showed that the F-ratio with the value of 2.15 showed that the whole model was significant at $P > 0.05$ probability level. The R^2 showed that 29% variation in level of market participation was explained by the included explanatory variables. The non-inclusion of relevant explanatory variables in the model might be the reason for the low $R^{2.}$ Findings revealed that six variables were significant at various probability levels. Extension services and market type were positive and significant at $P > 0.01$, gender of the farmer and household size at $P > 0.05$ while transportation fare was significant at $P > 0.1$. However, market information was negative but significant at $P > 0.1$ which implied that access to market information led to reduction in market participation. This is however contrary to *a priori* expectation but this could occur when farmers could not access current, relevant, reliable and accurate market information at the right time. All market participants involved in product creation, as well as the purchasing and selling of items, including rice, requires market knowledge on a regular basis. This is especially true in the case of agricultural products, as their prices fluctuate more than those of other industries. So, decision making process is hampered when market information is not easily accessed by the farmers. The finding is at variance with that of Macharias *et al.*, 2014 who reported that waiting time before receiving payment, market information and age of household head had negative influence on smallholder maize market participation. The finding however agrees with the report of Gani and Adeoti (2011) that market information, distance, output size, extension visit, cooperative membership, family size and education were the main determinants of intensity of market participation.

Table 3: Determinants of level of market participation among rice farmers in the study area

Robust Variables	Coefficient	t-value	P >| t |
Waiting time	-18.881	-1.53	0.130
Transportation fare	0.0396	1.92*	0.059
Age	-0.6475	-0.51	0.613
Gender	84.0263	2.30**	0.024
Marital Status	8.5579	0.24	0.813
Household size	9.2531	2.50**	0.014
Education	-11.5528	-1.05	0.298
Farer's experience in marketing	-1.4958	-0.73	0.465
Inclusion in social group	22.4536	0.48	0.632
Total annual income	-.0003	-1.26	0.211
Market information	-66.6639	-1.87*	0.064
Market type	131.1877	3.60***	0.001
Ownership of means of transportation	-1.3857	-0.04	0.969
Access to credit	-44.7610	-1.022	0.311
Extension services	171.0786	3.25***	0.002
Farm size	98.2473	1.16	0.248
Constant	8935.1480	67.11***	0.000

F-Ratio = 2.15; R^2 = 0.2932, * significant at 10%, **significant at 5%, ***significant at 1%

Constraints to market participation

Table 4 showed the constraints affecting market participation in the study area. The result revealed that the major constraints faced by the respondents were lack of infrastructure, high cost of transportation, unavailability of farmland and absence of government support for marketing which ranked 1st, 2nd, 3rd and 4th, respectively. The least of the constraints included high cost of land for rice cultivation rentage, inadequate investment capital and large family size which ranked 8th, 9th and 10th, respectively. The finding is at variance with the findings of Omiti *et al.* (2009) who reported that distance from farm to point of sale was a major constraint to the intensity of market participation.

Table 4: Distribution of respondents according to constraints to market participation

Constraints	Frequency	Percentage	Rank
Lack of infrastructure	72	72	1st
high cost of transportation	69	69	2nd
Unavailability of farmland	58	58	3rd
Absence of government support to improve marketing	52	52	4th
High cost of labour	50	50	5th
Unavailability of market	39	39	6th
Unavailability of improved rice varieties	37	37	7th
High cost of renting land	36	36	8th
Inadequate capital to invest	33	33	9th
Large family expenditure	14	14	10th

Source: Feild survey, 2018

Conclusion and Recommendations

Based on the findings of this research, it can be concluded that age, education, plot devoted to rice cultivation and household size were the major determinants of decision to participate while extension services, market type, gender of the farmer, household size and transportation cost were the major determinants of level (intensity) of market participation. The main constraints to market participation among rice farmers were infrastructural deficit, high cost of transportation, unavailability of farmland and absence of government support for marketing. It is therefore recommended that government should address the infrastructural deficit in term of existing road rehabilitation and construction of new roads to make market accessible to the rice farmers. Farmers should form cooperative marketing to ease the burden of transportation cost and increase their intensity of participation in the market.

REFERENCES

Abu, B. M. (2013). Market participation of smallholder farmers in the upper west region of Ghana. An M.Sc. Thesis submitted to the Department of Agricultural Economics and Agribusiness College of Agriculture and Consumer Sciences University of Ghana 45-60 Pp *http://ugspace.ug.edu.gh*

Gani, B.S. & Adeoti, A.I. (2011). Analysis of Market Participation and Rural Poverty among Farmers in Northern Part of Taraba State, Nigeria. *Journal of Economics*, 2(1), 23-36

Federal Republic of Nigeria (FRN). (2009). Federal Republic of Nigeria official gazette 96(2). B36pp

Holloway, G., Barrett, C. B. & Ehui, S. (2005). The Double-Hurdle Model in the Presence of Fixed Costs. *Journal of International Agricultural Trade and Development*, *1*, 17–28.

Holloway G. & Ehui S. (2002). Expanding market participation among smallholder livestock producers: A collection of studies employing Gibbs sampling and data from the Ethiopian highlands, 1998–2001. Socio-economics and Policy Research Working Paper 48. ILRI (International Livestock Research Institute), Nairobi, Kenya. 85 pp

Lapar, M.L., Holloway G. & Ehui, S. (2003). Policy options promoting market participation among smallholder livestock producers: a case study from the Phillipines. *Food Policy* 28, 187–211

Macharia, M.A., Mshenga, P.M., Ngigi, M., Gido, O.E. & Kiprop, K.J. (2014). Effect of transaction costs on smallholder maize market participation: Case of Kwanza District, Trans Nzoia County, *Kenya International Journal of Development and Sustainability* 3(4), 715-725

Mignouna D. B, Abdoulaye T., Akinola A. A, Kamara, A. Y. & Oluochi, M., (2016). Understanding market participation choices and decisions of maize and cowpea farmers in Northern, Nigeria. *Tropicultura* 34(1), 26-39

Muricho, G., Kassie, M. & Obare, G. (2015). Determinants of market participation regimes among smallholder maize producers in Kenya. Adoption Pathways project discussion paper 12. 1-2pp

David Tsokar (2021). Nigeria at a glance FAO of the United Nations, 2021 *https://www.fao.org/nigeria/fao-in-nigeria/nigeria-at-a-glance/en*

Omiti, J.M., Otieno, D.J., Nyanamba, T.O. & ccullough, E. (2009). Factors influencing the intensity of market participation by smallholder farmers: A case study of rural and peri-urban areas of Kenya. *Africa Journal of Food, Agriculture, Nutrition and Development*. 12(6), 1-5.

O'Neill A. (2021). Distribution of gross domestic product (GDP) across economic sectors Nigeria 2020 *https://www.statista.com/statistics/382311/nigeria-gdp-distribution-across economic-sectors Date accessed* 23/06/22

National Bureau of Statistics (2020): 2019 Poverty and inequality in Nigeria: Executive summary. A report

United Nations Population Fund (UNFPA) (2016). United Nations Population Fund Annual Report 2016

World Bank (2021). Poverty and equity: Africa western and central Nigeria *www.worldbank.org/poverty*

31 LIVELIHOOD DIVERSIFICATION STRATEGIES AND ITS EFFECTS ON FOOD SECURITY STATUS OF RURAL HOUSEHOLDS IN KADUNA AND KANO STATES, NIGERIA: A REVIEW

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ABSTRACT

This paper is a review of livelihood diversification strategies and its effects on food security of rural household in Kaduna and Kano States, Nigeria. From the literature reviewed, many livelihood diversification strategies were identified to influences food security of rural households among which includes on-farm, off-farm, non-farm, seasonal or permanent migration. Despite the fact that about 70% of Nigeria's population are engaged in agricultural production for livelihood. Nigerian agriculture could not produce enough food to meet the needs of her teeming population, thus the need for diversification for improved livelihood. The findings of the majority of the literature reviewed, point to the fact that livelihood diversification has positive effect on food security. Some of the identified constraints associated with the livelihood diversification strategies among the farming households include poor asset base, inadequate credit facilities, poor government support, lack of awareness and lack of modern processing equipment. It is apparent that the adoption of livelihood diversification strategies can enhance income generation, food security, self-sufficient, create wealth for other purposes and improve the overall living standard of the rural household.

Key words: Livelihood, diversification strategies, farming household, food security.

INTRODUCTION

Agriculture has been mainstay of Nigeria economy with regards to employment and linkages with the rest of the economy. It contributed 23.78% to the Gross Domestic Product (GDP) in the second quarter of 2021 (Nigeria Bureau of Statistic (NBS), 2021). About 70% of Nigeria's population are engaged in agricultural production but at a subsistence level (Adebayo and Olagunju, 2015). Despite this large percentage, Nigerian agriculture could not produce enough food to meet the needs of her teeming population, thus the need for diversification for improved livelihood. Livelihood diversification is defined as the number of economic activities a household unit is involved in and the shares of those activities in the overall economic activity (Kimenju and Tschirley, 2008). According to Tenaw (2016), rural livelihood diversification strategies encompass on-farm, off-farm and non-farm economic activities geared towards improved food security. Meanwhile, the inability of farming as a primary source of income to guarantee sufficient food production and security among farming households has brought to fore issue of livelihood diversification. According to Babatunde (2012), livelihood diversification by farm families is identified as a key strategy for improving food security. Thus, it is a process through which rural households engage in series of economic activities in order to survive and improve their standard of living (Tashikalma *et al.*, 2015).

LITERATURE REVIEW

Concept of Livelihood diversification

Livelihood diversification (Individual or household diversification) simply entails the addition of new activities. This can include agricultural or non-agricultural work, working for oneself or for an employer, working from home or elsewhere. The process by which rural households build an increasingly complex portfolio of activities and assets in order to survive and improve their standard of living has been described as rural livelihood diversification (Yisa *et al.*, 2019; Ogaji *et al.*, 2018; Ogaji *et al*., 2019). It also implies a process of dynamic change and constant adaptation (Ellis, 2000).

Attempts have been made by individuals and households to find new ways to raise incomes and reduce risk, which differ sharply by the degree of freedom of choice and the reversibility of the outcome. Livelihood diversification includes both on and off-farm activities which are undertaken to generate additional income from the major agricultural activities, via the production of subsidiary agricultural and non-agricultural goods and services, the sale of wage labour, or self-employment in small firms, and other strategies undertaken to minimize risk. These include activity or environment diversification in agriculture (Losch *et al*., 2010).

Livelihood diversification strategies

According to Department for International Development (DFID) (1999), livelihood strategies are defined as the range and combination of activities and choices that people make to achieve their livelihood goals, including productive activities, investment strategies and reproductive choices among others. Diversification can be divided into two categories, on-farm and non-farm diversification. On-farm diversification means "maintenance of a diverse spread of crop and livestock production activities that interlock with each other in various ways". A conventional example is a mixed cropping or intercropping, which refers to growing two or more crops on the same piece of land to "take advantage of complementarities between crops in their use of soil nutrients, sunlight and other resources" (Ellis, 2000).

Non-farm diversification refers to seeking business or employment opportunities other than traditional crop production and livestock rearing {Barrett *e tal.*, 2001}. Even non-farm diversification is related to agriculture as it includes processing and trading of agricultural produce. Also, non-farm activities include service provision, trade and business, manufacturing, craft, artisan work, commerce and skills like knitting, as an important component of rural household income-generating activities. According to (Ellis, 1998) It is defined as a process by which household members construct a diverse portfolio of activities and social support capabilities in their struggle for survival and to improve their standards of living.

METHODOLOGY

The study areas for this review focus on Kaduna and Kano States where some articles were review from related literature. The review articles were sourced from published and unpublished materials like books, journals, reports from national and international organizations (governments), non-governmental organizations, policy briefs, and other indexed scholarly materials. The review discussed some concepts evident on livelihood diversification and food security situations of rural households in the study area especially the effects of livelihood diversification on food security status of rural households.

REVIEW DISCUSSION

Effect of livelihood diversification on food security status of rural households

Food security among household is significantly higher with high level of livelihood diversification. This further implies that livelihood diversification had significant and positive effect on the food security status of household. Household per capita income, access to credit all had a positive and significant effect on food security of rural household. This review is similar to previous findings reported by Awotide *et al*. (2010), Omotayo (2016), Durba *et al.* (2019a) and Yisa *et al*. (2019) that household income and access to credit had significant effect on food security among rural farm households in Nigeria.

There were varying findings as regards the effects of livelihood diversification strategies on food security. Some findings found rural livelihood diversification strategies to had significantly positive effect, while others reported significantly negative effects. According to Omotayo (2016), farming is the main livelihood strategy of most African countries including Nigeria. At different level of governance, the policy focus is to increase agricultural productivity and farm income to attain food self-sufficiency. Meanwhile, several studies defined different socio-economic characteristics of the households that significantly influence the level of livelihood diversifications and food security situations, and presented the nexus between livelihood diversifications and food security.

CONCLUSION

In Nigeria, as in most African countries, there is a pressing need to improve household food security. Food insecurity in Nigeria derives directly from dependence on a single livelihood source which is based on low-input and low-output rain-fed agriculture. However, non-farm livelihood diversification strategies play a key role in the food security improvement of households in Nigeria. Currently, efforts to achieve food security should remain the primary concern of government mainly towards those household with lower-income or vulnerable groups in the country.

It is thus, important to identify the major factors influencing non-farm and off-farm livelihood diversification strategies and their effect on the food security status of rural households through reviewing previous works that are related and relevant to the topic. Therefore, household are enjoined to intensify efforts to diversify their livelihood, engage and invest their income in productive off-farm and non-farm activities for sustainable food security.

REFERENCES

Adebayo, O. & Olagunju K. (2015). Impact of Agricultural Innovation on improve livelihood and productivity outcomes among smallholder farmers in rural Nigeria, Working Papers 07, FAO Rome, Italy.

Awotide, O. D., Kehinde, A. L. & Agboola, P. O. (2010). Poverty and rural livelihood diversification among farming household in South-West Nigeria. *Journal of Food, Agriculture & Environment,* 8 (1), 367 – 371.

Babatunde, R. O. (2012). Income Portfolios in Rural Nigeria. Composition and Determinants. *Trends in Agricultural Economics*, 1, 35 – 41.

Barrett, C. B., Reardon, T. & Webb, P. (2001). Non-farm income diversification and household livelihood strategies in rural Africa: Concepts, Dynamics and Policy Implications. *Food Policy*, 26 (4), 315 – 331.

Department for International Development (DFID) (1999). Sustainable Livelihoods Guidance Sheet. Brighton: Oxford University Press.

Durba, A. M., Adewumi, A., Mohammed, U. S. & Adebayo, C. O. (2019a). Effects of SG-2000 on food security status in Kaduna State, Nigeria. FUDMA *Journal of Agriculture and Agricultural Technology*, 5 (1), 197 – 202.

Ellis, F. (1998). Household strategies and rural livelihood diversification. *Journal of Development Studies*, 35 (1), 1 – 38.

Ellis, F. (2000). *Rural Livelihoods and Diversity in Developing Countries*. London: Oxford University Press.

Kimenju, S. C. & Tschirley, D. (2008). Agriculture and Livelihood Diversification in Kenyan Rural Households. Tegemo Institute of Agricultural Policy and Development, Nairobi, Kenya.

Losch, B., Fréguin-Gresh, S. & White, E. (2010). Structural Dimensions of Liberalization on

Agriculture. Washington D.C.: World Bank.

National Bureau of Statistics (NBS) (2021). *Annual Abstract of Statistics 2007*. Nigeria Institute of Socio-Economic Research (NISER), FCT, Abuja, Pp 24.

Ogaji, A., Adewumi, A., Ibrahim, M. & Danlami, C. D. (2018). Analysis of Income Diversification among Fish Farmers in Shiroro Local Government Area of Niger State, Nigeria. *Journal of Agricultural Research and Development*, 17 (1), 19 – 29.

Ogaji, A., Adewumi, A., Ibrahim, M. & Ocheja, F. A. (2019). Livelihood Diversification and Income Inequality among Households in Minna Metropolis, Niger State. Proceedings of the 1st International Conference of Agriculture and Agricultural Technology (ICAAT) held at Federal University of Technology, Minna, Nigeria from 23rd – 26th April, pp 512 – 519.

Omotayo, O. A. (2016). Economic synergy between rural off poverty in Ekiti State, Nigeria. *Journal of Human Ecology*, 56 (1 & 2), 99 – 106.

Tashikalma, A. K., Michael, A. & Ciroh, D. Y. (2015). Effect of livelihood diversification on food security status of rural farming household in Yola south Local Government Area of Adamawa state, Nigeria. *Adamawa State University Journal of Agricultural Sciences (ADSUJAS)*, 3 (1), 33 – 39.

Tenaw Z. (2016). Constraint of pastoral and Agro-pastoral Livelihood Diversification in Eastern Ethiopia. The case of Mieso District, Oromia Regional State, Ethiopia.

Yisa, E. S., Coker, A. A. A., Etonihu, K. I. & Adewumi, A. (2019). Effects of Conflicts on Food Security and Poverty Status of Irish Potato Farmers in Plateau State, Nigeria. Proceedings of the ECONAGRO 3rd International Conference on Food and Agricultural Economics held at Alanya Alaaddin Keykubat University, Alanya/Antalya, Turkey from 25th – 26th April, pp 311 – 320.

32 DETERMINANTS OF FINANCIAL INCLUSION AMONG WOMEN UNDER RURAL FINANCE INSTITUTION BUILDING PROGRAMME IN NORTHERN NIGERIA

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Abstract

The study was undertaken to analyze the determinants of financial inclusion among women under Rural Finance Institution Building Programme (RUFIN) in Northern Nigeria. Study utilized primary data collected by questionnaire administered to 390 women beneficiaries and equal number of non-beneficiaries selected through multi-stage sampling procedure. Financial inclusion statuses of women were determined by using financial inclusion index which was computed as a ratio of credit amount in Naira equivalent obtained from a formal financial source by ith woman to two-third of mean of the total credit accessed by all women. Logit regression model was used to analyse the determinants of financial inclusion. Results showed that 34.62% and 9.23% of women beneficiaries and non-beneficiaries were financially included respectively. Age of women, membership of self-help group, availability of banks and their agents, availability of variety of financial services, trust in financial institutions and perceptions of conditions precedent to opening account had significant coefficients at 0.01. Similarly, gender of household head, years of formal education and annual composite income of women had significant coefficients at 0.05 while distance to service point had significant coefficient at 0.1. Study concludes that financial inclusion is still low among women in Northern Nigeria therefore limiting their potentials to benefit optimally from the economy. Study recommends policy thrust for the apex bank and strategies for financial institutions that will improve financial inclusion among women in the study area.

Keywords: Rural finance, financial inclusion, gender finance, Northern Nigeria, RUFIN

INTRODUCTION

Despite several efforts by Government and the private sector, financial exclusion in Nigeria remains phenomenal. Report showed that in 2020, nearly 1 in 2 Nigerian adults do not use any formal (regulated) financial services while more than 1 in 3 Nigerian adults remained completely financially excluded. This puts the financially excluded adult population at 38.1 million which is equivalent of 35.9% of the adult population (EFInA, 2021). Worse still, there are evidences of disproportionate differences in financial inclusion based on geography and gender in Nigeria. For instance, the average financial exclusion in Northern Nigeria stood at 48% compared to 21.67% in Southern Nigeria (EFInA, 2021). Further, 40% of adult women was financially excluded compared to 32% of their male counterparts in 2020, leaving the gender gap in terms of financial inclusion at 8% (EFInA, 2021).

The Rural Finance Institution Building Programme (RUFIN) was originally designed to expand production and improve productivity of agriculture and micro-small rural enterprises through appropriate credit linkages between the formal financial system and rural communities in the programme area. The objective was to develop rural financial services and enhance the accessibility of the poor rural people to these services (RUFIN, 2013). RUFIN prioritized women as target beneficiaries. Various researches have used different indicators as measures of financial inclusion but none as the authors are aware applied the use of financial inclusion index as a basis for determining financial inclusion statuses of women. There are also limited data on determinants of financial inclusion among women in Northern Nigeria especially with respect to economically active women that benefitted from a programme such as RUFIN. Hence, the main objective of the study is to analyze the determinants financial inclusion among women under Rural Finance Institution Building Programme in Northern Nigeria.

METHODOLOGY:

Sampling Procedure: Multistage sampling technique was adopted. Stage one involves purposive selection of North East, North West and North Central zones while stage two involves random selection of three states out of the six states where RUFIN intervened. Stage three involves purposive selection of all the women groups in the 3 participating LGAs per state while stage four involves determination of sample size using Yamane (1967) followed by application of proportionate sampling technique to select number of respondents in the communities in each LGA. Lastly, equal number of beneficiaries were selected for the non-beneficiaries.

Study Area: The Study was conducted in Bauchi, Katsina and Benue States of Nigeria

Data Collection: Primary data were collected using structured questionnaire with the aid of well-trained enumerators.

Data Analysis and Model Specification:

Data were analysed using a combination of descriptive and inferential statistics with the aid of Excel and STATA software.

Analysis of financial inclusion statuses of women: Financial inclusion index (Finc.) was used to determine the financial inclusion statuses of women. It was computed by adapting the food security index formula by Omonona and Agoi (2007).

Table 1: Sampling design for the study

STATE	LGA	Communities	No. of Groups	Sample Frame (No.of Beneficiaries)	Proportionate Sample size
Benue	Apa	6	167	3,340	85
	Gwer West	4	96	1,920	49
	Logo	8	163	3,260	83
Katsina	Sandamu	16	56	1120	29
	Funtua	29	56	1120	29
	Dutsin Ma	14	42	840	21
Bauchi	Bauchi	42	101	2020	51
	Katagum	10	37	740	19
	Ningi	21	47	940	24
				15300	390

Source: Computed from data available from RUFIN

Access to credit from formal sources was used as a proxy for financial inclusion. Hence, financial inclusion index (Finc.) was computed as:

$$\text{Finc} = \frac{\text{Credit amount in Naira equivalent accessed by the ith woman}}{\frac{2}{3}\text{mean credit amount in Naira equivalent accessed by all women}} \qquad (1)$$

Finc. = Financial inclusion index

When Finc. ≥ 1; the ith woman is financially included; when Finc.< 1; ith woman is financially excluded

Logit regression model: Following Gujarati and Porter (2009), logit regression model was adopted for the study. The logit model is designed to analyze qualitative data reflecting a choice between two alternatives, which in this case are the financially included and financially excluded. The choice of the logit model is premised on the fact that ordinary least squares assumes a continuous dependent variable while in the case of financial inclusion, the response is a binomial process taking the value 1 for financially included and 0 for financially excluded. Probability of being financially included is specified as the value of the cumulative distribution function which is specified as function of the explanatory variables. The logit model for probability of being financially included or otherwise and the determinants of financial inclusion is as follows:

$$Y_i = \beta_0 + \beta_1 Ag + \beta_2 GHH + \beta_3 GEN + \beta_4 EDU + \beta_5 HS + \beta_6 PrimOcc + \beta_7 Inc + \beta_8 ScaleEnt + \beta_9 MemSHG + \beta_{10} PosSHG + \beta_{11} AvailBA + \beta_{12} AvailVFSP + \beta_{13} TrustFI + \beta_{14} CB + \beta_{15} PercCPA + \beta_{16} Dist + \beta_{17} Pov + \beta_{18} Prod + \beta_{19} Ben + \varepsilon_i - - - - - - - - - (2)$$

Where independent variables are:

Age of respondents (years), Gender of Household Head (Male: 1; otherwise 0), Gender of respondent (Male: 1; otherwise 0), Education level (No of years spent in formal education), Household Size (number), Primary occupation (1= Farming, otherwise:0), Income level (Amount in Naira), Scale of enterprise (Value of assets excluding land and building), Membership of Self Help Groups (1= Yes, 0= otherwise), Position on self-help group, Availability of Banks or their agents (Yes= 1, otherwise = 0), Availability of variety of financial service provider (Yes=1, otherwise= 0), Trust in financial institutions (Trust index: Trust very strongly (1.0), Strongly trusts (0.8), Moderately, Trusts (0.6), Strongly distrusts (0.4), Distrusts very strongly (0.2), Cost of borrowing (Amount in Naira), Perception of conditions precedent to access (Easy = 1, otherwise = 0), Distance from respondent's residence to service point (Km.), Poverty Status (1 = Poor, 0 = otherwise), Productivity Score (actual score), Level of benefits (weighted score)

RESULTS

The results of the financial inclusion statuses of women beneficiaries and non-beneficiaries, determinants of financial inclusion and marginal effect of explanatory variables of financial inclusion are shown in the following tables:

Table 2: Financial inclusion statuses of women beneficiaries and non-beneficiaries of RUFIN

Variables	Beneficiaries		Non-Beneficiaries	
Finc. Status	Frequency	Percentage	Frequency	Percentage
Included	135	34.62	36	9.23
Excluded	255	65.38	354	90.77
Total	390	100.00	390	100.00

Source: Field Survey, 2019 * Finc. Status= Financial Inclusion Status of Women

Table 3: Determinants of financial inclusion

Variable	Coefficient	Standard error	z-value
Constant	-7.4753	0.8303	0.900
Age of respondent	0.0300***	0.0100	3.00
Gender of household head	-0.5771**	0.2494	-2.31
Years of formal education of respondent	0.0463**	0.0229	2.02
Years of formal education of household head	.00572	0.0206	0.28
Annual composite income	5.26e-07**	2.13e-07	2.47
Asset value	3.03e-07	3.21e-07	0.94
Membership of Self Help Group	2.1453***	0.4586	4.68
Position in self-help group	-0.3457	0.2673	-1.29
Availability of banks and their agents	2.0972***	0.3170	6.62
Availability of variety of financial services	0.7896***	0.2629	3.00
Trust in financial institution	1.1938***	0.3827	3.12
Interest rate	-0.0348	0.0296	-1.18
Perception of conditions precedent to opening account	1.1478***	0.2988	3.84
Distance to service point	-0.0285*	0.0147	-1.93
Poverty status	0.3385	0.2364	1.43
Productivity score	-0.0072	0.0119	-0.61

Chi (16) = 257.40; Prob > Chi2= 0.0000; Pseudo R2 = 0.3137; Log likelihood= -281.5269
*** = significant at 0.01; ** = significant at 0.05; *= significant at 0.1
Source: Field Survey, 2019

DISCUSSION

Table 2 presents information on the proportion of financially included or otherwise for both beneficiaries and non-beneficiaries. From table 3, 34.62% of the women beneficiaries were reported to be financially included while only 9.23% of the non-beneficiaries were financially included.

Table 3. presents the results of logistic regression model that was used to estimate the determinants of financial inclusion. As shown in the table, age of women, membership of self-help group, availability of banks and their agents, availability of variety of financial services, trust in financial institutions and perceptions of conditions precedent to opening account had significant coefficients at 0.01. Similarly, gender of household head, years of formal education and annual composite income of women had significant coefficients at 0.05 while distance to service point had significant coefficient at 0.1. The positive coefficient (0.03) for the age of women implies

that older women have higher likelihood of being financially included. The coefficient for gender of household head was negative (-0.5777). Since the model was stereotyped in favour of the male gender, the negative coefficient implies that female-headed households are more likely to be financially included. This contradicts apriori expectations because male headed households are known to have access to more economic assets and opportunities. However, there has been an increased crusade in favour of access to credit (which is the proxy for financial inclusion in the context of this study) for women in recent times. This may have indirectly contributed to this result. The coefficient for formal education was positive (0.0463). This implies that education impacts positively on financial inclusion. The more educated a woman is, the higher the likelihood of financial inclusion. The annual composite income also had a positive coefficient (5.26e-07); implying that increase income increases the likelihood of financial inclusion. Membership of self-help group had a positive coefficient (2.1453); affirming that social capital increases the likelihood of access to financial services (inclusion). Availability of banks and their agents had a positive coefficient (2.0972); indicating that availability of banks and their agents within a given locale will increase access to financial inclusion among women. Availability of variety of financial services also had a positive coefficient (0.7896). This meets the apriori expectation indicating that the more the options for financial services that are available, the higher the likelihood of financial inclusion among women. Trust in financial inclusion also had a positive coefficient (1.1938). This denotes that the degree of positive perception about the reliance of financial service providers increases the likelihood of patronage by clients which translates to financial inclusion. Perception of conditions precedent to opening account (1.1478) had a positive coefficient. This implies that if financial service providers make conditions precedent to opening account less cumbersome and also create a positive psyche about this to customers, there is higher likelihood of increased financial inclusion. Distance to service point had a negative coefficient (-0.0285); denoting that service points being distant from clients increases the burden for access to financial services thereby translating to financial exclusion.

CONCLUSION AND RECOMMENDATIONS:

Study concludes that despite the active involvement of women in agriculture with other rural enterprises and their potentials to scale, their level of financial inclusion is very low thereby limiting their capacities to benefit optimally from the economy. There are various factors responsible for low rate of financial inclusion among women which requires concerted efforts from government and private sectors to change the trajectory. Based on the foregoing, study recommends that:

1. Policy thrust from the apex bank that will both constrain and incentivize lending to women owned enterprises in rural areas by financial institutions should be promoted. This will help to better harness and scale the productive potentials of women entrepreneurs in those locales and improve rural economy.
2. Financial institutions should prioritize lending to older economically active women and those who are members of self-help groups with records of savings and repayment capacity.
3. Financial institutions should be incentivized to increase the availability of services in rural areas through provision of more service points, agency banking and digital banking so that the huge potentials in the financial inclusion gap in these areas can be bridged. These services can be offered through collaborations for example with telcos, post-offices, fuel stations and other institutions with legacy assets in rural areas.
4. Financial institutions need to redesign and simplify account opening and loan application processes without necessarily compromising their systems to encourage patronage from rural based women entrepreneurs for increased financial inclusion. These efforts should be complemented with increased advocacy to earn the trust of potential customers in financial institutions.

REFERENCES

Enhancing Financial Innovation and Access in Nigeria (EFInA) (2021). Key Findings: EFInA access to financial services in Nigeria 2020 survey, www.efina.org.ng.

Gujarati, D.N & Porter, D.C. (2009). Basic Econometrics (Fifth Edition ed.). New York, America: McGraw-Hill/Irwin, Pp 922.

International Fund for Agricultural Development (IFAD) (2006): Rural Finance Institution Building Programme, appraisal report volume 1 – main report and appendices (Report No. 1823-NG), November 2006.

National Population Commission (2020). Nigeria population projections and demographic indicator- States and National. Abuja, Nigeria

Omonona, B.T., and Agoi, G.A. (2007): An analysis of food security situation among Nigerian urban households: Evidence from Lagos state, Nigeria. Journal of Central European Agriculture, 8-397-406.

Rural Finance Institution Building Programme (RUFIN) (2013): Mid-term review report. Report No. 3109-NG submitted 30 May, 2013, pp. 1-2.

Yamane, Taro. 1967. Statistics, an introductory analysis, 2nd Ed., New York: Harper and Row.

33 IDENTIFYING STAKEHOLDERS' INTEREST IN SALINE QUINOA FARMING ALONG VALUE CHAIN IN MOROCCO

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Abstract

Salinity in Morocco deepened by its coastal position and low rainfall amount severe the climate change adaptation and sustainability of the country. This study objectively set to map relevant stakeholder's interest, networks and possibly their preference in quinoa farming in Morocco. Stakeholder analysis was used to identify the relevant stakeholders along the value chain groups in quinoa farming in Morocco. These farmers were engaged in a Focus Group Discussion (FGD) where exploratory questions were asked using semi structured interview questionnaire. Classic content of the focus group discussions was analyzed in a mixed method approach applying triangulation method. Three value chain groups (Farmers production group, women processing group and the extension agents) were interviewed and their interests varied. The farmers production group's interest was due to the resistance of quinoa to saline water and the women group was to innovate. However, they all had challenge of low knowledge of the crop while being optimistic that quinoa could salvage the situation on ground. The producers' groups had no existing networks at the moment because it is a new crop and so no preferences were identified. But the women group already had network. Therefore, knowledge management technologies should be deployed to enhance the production of this adaptive crop to salinity.

Keywords. Quinoa, salinity, stakeholders, value chain, interest

Introduction

In the face of changing climate, the semi-arid regions are mostly affected with salinity as a result of sea level rise. Salinity is one abiotic stress that greatly retard agricultural production due to increased phytotoxic ions around the root zone that hinders water uptake in plants (Mokhena *et al*., 2016). Climate change also means high CO_2 emission to the atmosphere. In some cases halophytes (salt tolerant), C3 plants, are promoted by high CO_2 but unfortunately, high temperature and high evapotranspiration reduces their yield (Ullah *et al*., 2021) and impacts on soil salinity. In hot dry regions of North Africa such as Moroccan, farmers battle these factors to produce crop. These force them to adopt adaptation strategies to cope with the biotic and abiotic stress in the region.

Morocco, is a country with very low annual rainfall amount ranging from 100 - 1,200mm on the average across the country. This is basically because of its position on the coast which exposes the country to Sea intruition (Hssaisoune *et al*., 2020) as its source of salinity. Other anthropogenic causes also raise the salinity problem of this country and much fears if the expected decrease in precipitation occurs. Moroccan farmers have adopted the cultivation of rustic quinoa to adapt to the salinity in their environment (Hirich *et al*, 2021). Quinoa is a C3 plant that is morphologically structured to adapt to high temperature. The country has engaged several efforts in battling this challenge such as use of bio saline agriculture by engaging alternative crops to adapt to the saline conditions (Hirich *et al*., 2021). It is therefore interesting to find out what drives farmer's interest to even build initiatives into quinoa farming. What framework affects actor's preference and networks in their adaptation moves. There is need to access these possibilities in view of scaling up as a highlight to acceptance of alternative crops as a strategy to salinity in changing climate.

The social framework around a particular case affects its acceptance or sustainability. Projects, policies and innovative ideas fail up to 50% due to improper or non-engagement of key stakeholders (Inam *et al*., 2015). Researchers have engaged stakeholder in environmental projects and water related researches (Inam *et al*., 2015: Akramkhanov *et al*., 2018: Hargrove & Heyman, 2020) yet, 'real change' is still elusive. Despite the elusiveness, multilevel perspective framework was applied in Netherland by Beauchampet, (2022), to study stakeholders perspective on the issue of saline agriculture. Furtherance use of this tool is to apply same technique in Morocco to see what drives the stakeholders despite little knowledge of the salt tolerant crops. However, including the systematic approach of drawing out the interest along the value chain. Systematic process is needed to know the relationships of these stakes by employing stakeholder analysis. The identification of relevant stakeholders in this project will also extract their awareness on the situation and becomes a route to propagate the innovative techniques if they are properly involved. This study therefore objectively seeks to understand the stakeholder's interests and networks and to determine the framework that affects their preferences.

Methodology

In this section, we give the study background and as well, relate the methodology for mapping the key stakeholders' interest and networks while extracting their preferences if possible. This will be followed by the overview of stakeholder analysis. Then the data collection methods, data analysis, result/discussion and the conclusion.

Study Background

Saline Agriculture as a Strategy to Adapt to Climate Change (SALAD) is an intercontinental project that transverse four North Sea countries in Europe (Italy, Netherlands, Belgium, Germany) to North Africa (Morocco, Egypt) to revert the continuous resource depletion as a result of climate change. The project is a consortium of transdisciplinary researchers combating soil salinity risk which is gruesomely challenging food security. This problem has reduced food production whilst receiving little attention from both the private and public sector. It is important to harness the science and technologically innovative approach of applying alternative crop to possibly reach neo institutional theory in the attempt of attaining governance landscape. It is due to the rising sea level and other climatic and anthropogenic reasons that soil salinity is severe. In line with the Paris agreement 2030 to combat climate change, this project has focused on sustaining and innovatively developing techniques that will adapt to salinity challenges by using salt tolerant crops with the goal of upscaling crop/food chains across the regions and exchanging solutions among (source and end) stakeholders. It was imperative to harness the interests of these stakeholders to ensure adoption of developed techniques and policies. The project was designed to have different case studies, where each country with a crop of interest is designated as a case study. The case study in Morocco is focused on understanding the stakeholders' interest and networks along the value chains of Quinoa.

Overview of Stakeholder analysis (SHA)

Among the definitions of stakeholder analysis given by Reed, (2008), identifications of individuals and groups who are affected by or can affect those parts of the system and prioritizing these individuals and groups for involvement in the decision-making process suits. In appropriation, we have considered social network analysis to investigate network relationships. This is to enable us analyze social interactions that map patterns of relationship and information flows to reveal stakeholders' differences in relevance (Borgatti, 2006). Bertoni *et al*., (2022) stated one strength of SNA (Social Network Analysis) that it allows the gathering of opinion from a large number of people using transparent and replicable method which negates ascribing the most relevant to the most outspoken, most fronted and most ambitious members. This is why we employed the focus group discussion to focus on the in-depth understanding of people and the social issue. SNA uses all the centrality (in-degree, in-betweenness and closeness) measures to determine relevance which makes it complete. These measures are then theoretically connected to the subject of discuss. One difficult task marked by (Ostrom, 2009) is the ability to understand relationships among multiple level at different spatial variables. The multilevel nested framework was updated to arrest this problem and so will be employed in this paper, seeing value chain as different levels. The framework can also be used to look at a sector of a whole.

Stakeholder identification and mapping method

This study employed the snowball technique to initiate stakeholder identification. SALAD project members were used to identify and snowball quinoa farmers/stakeholders in Laayoune, Morocco. Where farmers and their various groups were identified using structured interview questionnaire through farmers survey (Hirich, Personal discussion, 2022). The farmers survey was done by the The African Institute for Sustainable Agriculture Research (ASARI) socio economist however, there was no observation data about it. The quinoa value chain was already known by the research institute and were thus used for research outings. The following value chains were identified, producers, cooperatives/processors and extension agents.

The mapping tactics was done along the value chain system of quinoa farming. The common interest of being a quinoa producer, valorizer/women processing group, consumer, Extension agents, cooperative group, marketers etc. was the grouping factor. The approach of participation planning matrix which is based on stakeholder-issue inter-relationship (Mathur *et al*., 2007) was used. This was appropriate as we considered the different groups of farmers with same interest along a value chain. The combination of this approach with focus group discussion was employed to understand the stakeholders' interests, networks and preferences.

Data collection methods

Questionnaire development

In developing this questionnaire, we needed to find out the farmers' interests in farming saline quinoa, challenges they faced, the relationship they have in terms of their networks and possibly to know if they preferred saline quinoa to other crops. We targeted the different value chain members of quinoa farmers in Laayoune and gathered them in their different groups during a workshop organized by the African Sustainable Agriculture Research Institute (ASARI), Mohammed VI Polytechnic University (UM6P), Laayoune, Morocco to address Knowledge gap in quinoa farming. Three value chain groups were present at the workshop: farmers production group, the extension agent and the women processors groups. The question contents of each group were different. This was intentional since the members of the groups already belonged to designated value chain group, however, the ideas were still to get the above-mentioned information.

Data collection via interviews

The qualitative data collection technique used in this research was focus group discussions (FGD). This was organized for the farmers group and leading exploratory questions were asked to identify their interests, networks and their preference using semi structured questionnaire. The questionnaire was designed in English and administered in two languages (Arabic and French) with the help of UM6P research assistants. Eleven respondents formed the production value chain group and they were composed of mainly men as the region seemed to have men in production and female in processing sections. The extension agents' group were quite mixed of male and female unlike the other two groups.

Data analysis.

The data analyses were done using classic content analysis with focus on describing the codes as identified by the researcher. We have employed mixed method analysis using triangulation to clearly give understanding of the phenomena studied. Quantitative representations were done using the frequency observed in the study.

Results and Discussion

Drivers/interests, preference and networks of the stakeholders in the specific value chains of Quinoa

A. Production value chain

The focus group discussion on what determined producers' interest in quinoa production revealed the following; investment and profitability, salt-tolerant plants that flourish in high-salinity and high temperature (resistance to extreme weather conditions including diseases), new products adaptable to the region, creation of quinoa national and international market, value addition and job opportunities and easiness in production of the crop.

It was interesting to note that the crop's resistant to salinity (Fig.1) and not profit was producers' major reason for cultivating quinoa in Morocco. This is in agreement with the studies of Hirich, Choukr-Allah, *et al*., (2021), who stated that quinoa is a rustic crop and resistant to salinity. However, they experienced challenges and the major one was lack of government subsides (Fig.2) followed by the lack of knowledge of the crop. Lack of knowledge was expected since the crop was new in the region. That could also be the reason there was no existing networks within or outside Laayoune, Morocco for producers of quinoa. The farmers stated that the crop is new and the only way they could adopt more people to farm quinoa is if government gives subsides for production. They are currently test trying the crop and the only reason they will prefer quinoa to another crop is on the following conditions respectively; highly tolerant as they have already perceived, profitable and available technical support and subsides for the crop. For the moment, the only source of technical support is from trainings provided by ASARI-UM6P platform. They requested more of such trainings to avoid losing the existence of this crop in the region and for production to continue. This request indicates high interest in the crop despite its being a new crop.

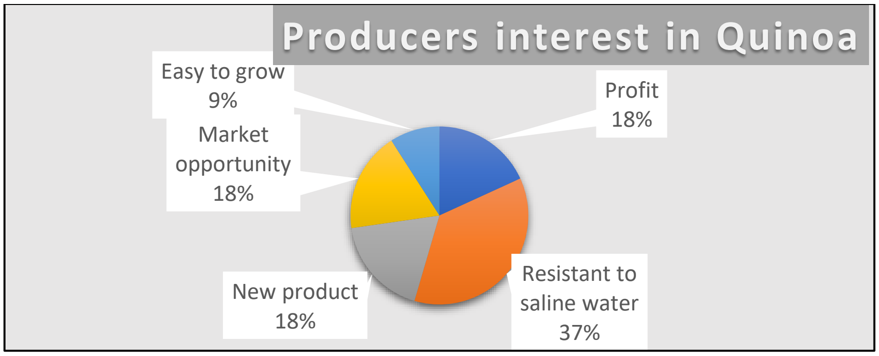

Figure 1. The Interest of Producers Value Chain farmers in growing Quinoa

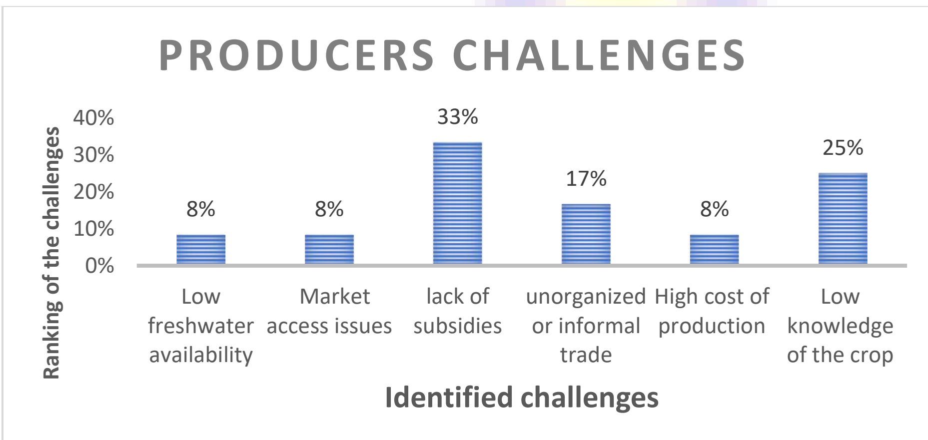

Figure 2. Challenges of the Producers value chain farmers

B. Extension Agent Value chain

The extension agents (EA) interviewed were mainly government workers who expressed farmers interest and acceptance they observed. Also discussed was the challenges experienced by EAs and their knowledge management strategies to enable triangulation of the drivers presented.

The EAs reported that farmers driving interest was the additional value the farmers got from the crop such as using the crop as both main product (food) and by-product to feed their animal since majority of them were animal breeders. This point contradicted the producers' (Fig. 1) main driver reported to be the crops' resistance to diseases, salinity and harsh weather conditions, however, it was among their interests but not the interest as represented by the frequency data. The other driver mentioned by both the EAs and the producers was 'profit'. There is likely a communication gap between the producers and the EAs or inadequate communication skills. Hence, Antwi-Agyei & Stringer, (2021), suggested developing EAs technical skills, improving their communication skills and equipping their knowledge tanks. They reported the farmers hesitancy in accepting the crop if it is not profitable. Stating no assurance that producers will fully accept the new crop until they confirm the benefits in farming saline quinoa.

In view of likely communication gap/skill inadequacy, the producer's relationship with the extension agents were diagnosed by studying the EAs knowledge sharing strategies. It was therefore understood from the focus group discussion that there was relatively no network relationship between the two groups in relation to quinoa production because the crop is new. The producers only obtain their information from the ASARI institute. The little information the EAs have about the producers were gathered during their Mentoring and coaching, training and visits and collaborations which was found as their knowledge sharing strategies (Table 1).

In agreement to the skill inadequacy observed from the discussion, the extension agents reported low technical knowledge of the product among others as their most challenge (Fig. 3) in delivering extension services for quinoa crop. The lack of knowledge of the quinoa in Laayoune is significantly different from the other challenges such as lack of raw materials, low market information and financial support.

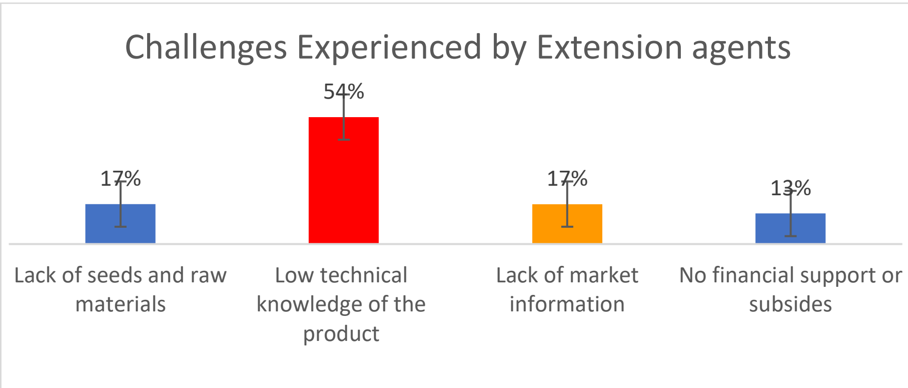

Figure 3. Challenges experienced by Extension Agents for carrying out extension services for quinoa.

Table 1. Knowledge sharing strategies identified in Laayoune

Mentoring and Coaching	collaborations	Training and visits
Meeting to share idea every week	Linking the Farmers to cooperatives or cooperate firms	Field visits
Technical project support with study, evaluation and supervision	Asking advice and consultation from the private sector	Seasonal training sessions
Provincial centres for consultation and advice		Excursion to model farms
		Farmers field schools and Workshops

C. Women group/processors

The women group as well as processors were also identified as cooperatives members. They undertake the duty of processing the quinoa and making it ready for marketing in different forms. They are small cooperative composed of women and fortunately have connection with the government that they can influence the government to support them financially. However, they have no influence on the market price insurance nor do they have off takers. They do not focus only on quinoa, they also process other crops and would prefer to have other crops such as rice, oath and carob if weather condition permits. These women have network relationship with the farmers in the North region of Morocco who supply them raw materials and other needed inputs. However, they have no power over their decision to either adopt saline quinoa or not.

The interests and challenges of this group was as well studied during the focus group discussion. It was revealed that innovatively developing new products, diversifying processed products and high demand of the new crop were the main drivers of their operations. Of course, they had some challenges such as lack of awareness of quinoa benefits and how best to further process it, high price of raw materials, cost of valorisation and transformation as well as branding and packaging of the products.

Potentials for improvements of saline agriculture value chains for quinoa in Morocco

The desert nature of Morocco has created limited options for the farmers in especially the southern region where this study was conducted. Notwithstanding, interestingly the women processors have given hope to the use quinoa as an alternative crop in the region. There innovative food products from the crop has been reported to be on demand by the people of that community. They make different food options from quinoa to replace the existing cereals that climate change was affecting thereby institutionalizing alternative (Fig. 4). These products were formerly made from rice, oath etc but can now also come from quinoa.

Figure 4. Different products produced from Quinoa by the women cooperatives

Conclusions and research outlook

The Moroccan case study has been studied and crop resistant to salinity was the major interest of the farmers for choosing the crop. It was not mainly the profit they make from the product as they do not know the profit margin for the crop yet. They also appreciate the other benefits they make from growing the crop such as using the by product for animal feed etc. On the other hand, it was notable that the women processors were more interested in their innovative adventures in producing more products as would have been made from rice or other cereals. This advancement was already attracting high demand and interest of farmers to the crop.

However, there was a cross cutting challenge of low knowledge of the crop and lack of raw materials. There is no strong existing network except for the women processors that collect raw materials from the group in the northern part of the country. This is an issue to consider and tackle. From these findings, there is possibility of accepting quinoa as an alternative in Morocco and upscaling possibilities is feasible.

References

Akramkhanov, A., Ul Hassan, M. M., & Hornidge, A. K. (2018). Redrawing soil salinity innovation-focused stakeholder interaction for sustainable land management in Khorezm Province, Uzbekistan. *Water (Switzerland)*, *10*(2), 1–17. https://doi.org/10.3390/w10020208

Antwi-Agyei, P., & Stringer, L. C. (2021). Improving the effectiveness of agricultural extension services in supporting farmers to adapt to climate change: Insights from northeastern Ghana. *Climate Risk Management*, *32*(March), 100304. https://doi.org/10.1016/j.crm.2021.100304

Beauchampet, I. C. (2022). Stakeholder Perspectives on the Issue of Salinization in Agriculture in the Netherlands. In E. B.-L. Katarzyna Negacz, Pier Vellinga & and T. E. Redouane Choukr-Allah (Eds.), *Future of sustainable Agriculture in Saline Environment* (Ist, pp. 208–229). by CRC Press 6000 Broken Sound Parkway NW, Suite 300, Boca Raton, FL 33487-2742 and by CRC Press 2 Park Square, Milton Park, Abingdon, Oxon, OX14 4RN © 2022. https://doi.org/10.1201/9781003112327-13

Bertoni, V. B., Saurin, T. A., & Fogliatto, F. S. (2022). How to identify key players that contribute to resilient performance: A social network analysis perspective. *Safety Science*, *148*(April). https://doi.org/10.1016/j.ssci.2021.105648

Borgatti, S. P. (2006). Identifying sets of key players in a social network. *Computational and Mathematical Organization Theory*, *12*(1), 21–34. https://doi.org/10.1007/s10588-006-7084-x

Hirich, A., Choukr-Allah, R., Ezzaiar, R., Shabbir, S. A., & Lyamani, A. (2021). Introduction of alternative crops as a solution to groundwater and soil salinization in the Laayoune area, South Morocco. *Euro-Mediterranean Journal for Environmental Integration*, *6*(2). https://doi.org/10.1007/S41207-021-00262-7

Hirich, A., Rafik, S., Rahmani, M., Amira, F., Azaykou, F., Filali, K., Ahmadzai, H., Jnaoui, Y., Soulaimani, A., Moussafir, M., Gharous, M. El, Karboune, S., Sbai, A., & Choukr-Allah, R. (2021). Development of quinoa value chain to improve food and nutritional security in rural communities in rehamna, morocco: Lessons learned and perspectives. *Plants*, *10*(2), 1–27. https://doi.org/10.3390/plants10020301

Hssaisoune, M., Bouchaou, L., Sifeddine, A., Bouimetarhan, I., & Chehbouni, A. (2020). Moroccan groundwater resources and evolution with global climate changes. *Geosciences (Switzerland)*, *10*(2). https://doi.org/10.3390/GEOSCIENCES10020081

Inam, A., Adamowski, J., Halbe, J., & Prasher, S. (2015). Using causal loop diagrams for the initialization of stakeholder engagement in soil salinity management in agricultural watersheds in developing countries: A case study in the Rechna Doab watershed, Pakistan. *Journal of Environmental Management*, *152*, 251–267. https://doi.org/10.1016/j.jenvman.2015.01.052

Mathur, V. N., Price, A. D. F., Austin, S., & Moobela, C. (2007). Defining, identifying and mapping stakeholders in the assessment of urban sustainability. *International Conference on Whole Life Urban Sustainability and Its Assessment*, 1–18. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.507.8759&rep=rep1&type=pdf

Mokhena, T., Mochane, M., Tshwafo, M., Linganiso, L., Thekisoe, O., & Songca, S. (2016). Salinity Stress in Arid and Semi-Arid Climates: Effects and Management in Field Crops. In

Intech (pp. 225–240). https://www.intechopen.com/books/advanced-biometric-technologies/liveness-detection-in-biometrics

Ostrom, E. (2009). A General Framework for Analyzing Sustainablility of Social-Ecological Systems. *Science*, *325*(July), 419–422. https://doi.org/10.1126/science.1172133

Reed, M. S. (2008). Stakeholder participation for environmental management: A literature review. *Biological Conservation*, *141*(10), 2417–2431. https://doi.org/10.1016/j.biocon.2008.07.014

Ullah, A., Bano, A., & Khan, N. (2021). Climate Change and Salinity Effects on Crops and Chemical Communication Between Plants and Plant Growth-Promoting Microorganisms Under Stress. *Frontiers in Sustainable Food Systems*, *5*(June), 1–16. https://doi.org/10.3389/fsufs.2021.618092

34 Effect of Climate-Smart Agricultural Practices on Food security of Rural Farming Household in Southwest, Nigeria

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Abstract

The study aimed at the effect of Climate-Smart Agricultural (CSA) practices on food security of rural farming households in Nigeria. Multi-stage sampling technique was used to select 480 rural farming households across three selected states in the Southwest, Nigeria. The data were analyzed using descriptive and inferential statistics - Foster-Greer-Thorbecke (FGT) and Logit regression analysis. The results revealed that majority (76.0%) of the respondents were married, while mean age, household size and farm size were 47.1 years, 5.31 persons and 3.77 hectares respectively and 72.0% with income from farming less than $250. Crop diversification is the most practiced CSA in the study area. Also, 57.95% of the farming households are food secured, while 42.05% are food insecure. The depth food insecure and severe food insecure among the sampled farming households were 0.1913 and 0.0711 respectively. The logistic regression result showed that the food security status of the rural farming households is significantly affected by gender, farm size, contact with extension agent and CSA practice. The study concluded that food security status of rural farming households in Nigeria was indeed influenced by CSA practiced in crop farming. Government and all stakeholders should promote and encourage the adoption of CSA practice that will ensure agricultural sustainability in agrarian communities through mitigating the effect of climate change.
Key words: Climate Smart, Agriculture, Crop diversification, Food security, Regression

Introduction

Food provision for households is a necessity, with approximately 820 million individuals globally being faced with the challenge of hunger, while over two-third of the world population were lacking essential nutrients, thus influencing their diet, well-being and life expectancy (Food and Agricultural Organization of the United Nations (FAO), 2019). Climate change is one of the environmental problems facing mankind. The implication of climate change cuts across various sectors, ranging from health to agriculture. Climate change has significantly affected global agriculture in the 21st century (Akanbi *et al*., 2021). The effects of climate change on agricultural production and food security are expected to intensify over time, and to vary across countries and regions (FAO, 2019). Despite its high contribution to the overall economy, this sector has been seriously facing challenges of many factors of which climate-related disasters like drought and floods are the major ones. Climate variability and change adversely affects agricultural sector and the situation is expected to worsen in the future (Brosch, 2021). There is a growing concern that climate change will seriously affect the ability to meet the food demands of about 10 billion world population come 2050, which is a significant reason why experts are promoting climate-smart agriculture (Akano *et al.*, 2022). Climate-smart agriculture (CSA) integrates socioeconomic and ecological components that ensure current food production activities do not affect the ability to produce food in the future. As it stands, conventional agricultural practices, which involve growing readily available low-yielding varieties with excessive nitrogen fertilizer application, are no longer sustainable due to adding to the release of greenhouse gases (GHGs) (FAO, 2019).

The adoption of CSA among farmers in developing countries especially in Nigeria is still low despite the numerous effort tailored towards the sensitization of farmers about its importance in mitigating against climate change (FAO, 2019). Akanbi *et al.* (2021) revealed that there are several factors contributing to low level of adoption of CSA in SSA ranging from technical know-how, poor awareness, cost, culture, and traditional beliefs, and poor infrastructures, financing, unsustainable government policy, and other socioeconomic constraints such as education level and years of farming experience. Amare *et al*. (2018), pinpointed that there is dire need of farmers to prepare towards climate change impacts by embracing adaptation and risk mitigation measures such as climate-smart agriculture so as to achieve food security in households level and globally. This article seeks to contribute to the body of knowledge on how to enhance food security in rural farming households through climate smart agricultural practices. The study aims to identify various CSA practises and to determine the effect of CSA practices on food security status using Nigeria as the case study.

Methodology

Study Area

This study was carried out in the rural Southwest, Nigeria which consists of six states, namely: Ekiti, Osun, Ogun, Oyo, Ondo, and Lagos. The area is bounded in the East by Delta State, the Republic of Benin in the West, Kwara and Kogi State in the North and by the Atlantic Ocean in the south. The major occupation in the geopolitical zone is farming, in which maize, cassava, yam, oil palm, cocoa and timber are equally produced comercially. Most rural families in the zone survive on subsistence farming, with supplementary income from other employment such as trading, hunting, food gathering and handcrfat. This resulted in the rural households dropping into a more severely poor category, resulting in the majority having to depend on savings and help from relatives.

Sampling techniques and data analysis

Primary data were used for this study and were collected through the use of a structured questionnaire. The sampling population consit of rural farming households majorly practice subsistence farming. A multi-stage sampling procedure was used to select 480 rural farming households across six states that made up the

Southwestern, Nigeria. First stage involved random selection of 50% of the states (Oyo, Ekiti and Ogun) that made up of Southwestern geopolitical zone. The second stage involved selecting two Agricultural Development Programme (ADP) Zones from each state, making six zones. The third stage involved randomly selecting two blocks from each of the six ADP zones, making 12 blocks. Fourth stage involved randomly selecting four cells from each of the 12 blocks, making 48 cells. Last stage, involved randomly selecting 10 households from each of the 48 cells, which totaled 480 rural farming households. The data collected were analyzed using descriptive statistics (means and frequencies). Logit regression model was used to determine the effect of CSA practices on food security status of the respondents, while the Foster–Greer–Thorbecke (FGT) Index was used to classify the farming households into food secure and insecure.

Results and Discussion

Descriptive statistics

Table 1 presents the socioeconomic characteristics of the respondents, with more than two-thirds of the households being male-headed (81.0%), with their mean age estimate at 47 years, thus revealing that they are expected to be productive with the available resources. This was in line with Akano *et al*., (2021), who pinpointed that the mean age of respondents in rural farming households of Nigeria was between the ages of 45 - 50 years. About 76.00% of the respondents were married, 78.00% had farming as their main source of livelihood activities with mean household size and farm size of 5 persons and 3.77 hectares respectively. Majority (72.00 percent) of the rural farming households earned less than $250.00 while about two-thirds (81.0 percent) of them had contact with extension agents. Extension agent is very important in information dissemination and adoption of new technology (Akter and Ahmed, 2021). The result of the climate smart agricultural practices (CSA) used by the respondents revealed that crop diversification is the form of CSAP mostly used in the study area. About 3.13% of the respondents are low users while 61.25% and 15.63% of the respondents are medium and high users respectively (see Fig. 2). The result was in line with Amare *et al*., (2018) who positioned that CSAP in rural areas are being silent and the importance are not well pronounced which could be the reason for its moderate usage in the study area

Table 1: Summary of the socioeconomic characteristics of the respondents (n = 480) $1 = ₦720

Variable	Mean	SD
Gender of respondent (1 = male, female = 0)	0.81	0.193
Age group (1 = adult; 0 = youth)	47.1	0.201
Education level of respondent (1 = formal; 0 = Non formal)	0.62	0.117
Household size (number)	5.31	0.410
Marital Status (1 = Married; 0 = Otherwise)	0.76	0.291
Farm size (hectares)	3.77	1.321
Farming experience (years)	8.23	1.092

Contact with extension agent (1 = yes)	0.81	0.018
Main source of income: (1 = Farming, 0 = Others)	0.78	0.512
Income from farming: <250 USD	0.72	0.221
251 - 500 USD	0.20	0.012
> 500 USD	0.08	0.162

Table 2: Climate Smart Agricultural Practices (CSAP) and Degree of Usage

CSAP	WMS	SD
Crop diversification	4.723	1.004
Crop rotation	4.281	0.961
Mulching	2.104	0.452
Agroforestry	1.982	0.142
Use of Organic manure	3.441	0.811
Use of Fadama land	2.981	0.051
Planting crops with early maturity	3.831	1.031
Planting drought-tolerant crop varieties	4.016	1.441
Planting cover crop	1.052	1.113
Intercropping	4.101	0.742
Irrigation	1.961	0.022

WMS = Weighted Mean Score SD = Standard Deviation

Food security status of the respondents

Following Omotayo (2016), food insecurity parameters used were P_0 (food insecurity incidence (headcount)), P_1 (depth food insecurity) and P_2 (severity food insecurity). Food insecurity (head count), represents the proportion of household below the food security line. The results showed that the head count ratio or incidence of food insecurity within the households was 0.4205, indicating that 42.05% of the respondents were food insecure (unable to meet the daily recommended food security threshold) while 57.95% were food secure (Table 3). To identify the extent to which the food insecure households are below the recommended food security threshold, the food insecurity gap was calculated. This gap illustrates the various categories of the food insecurity situation experienced by the farming households in the study area.

The P_1 (depth food insecure) among the sampled farming households was 0.1913. This implies that if resources could be mobilized to meet 19.13% of caloric requirement of every food insecure households, theoretically, food insecurity can be eliminated. The value P_2 (severe food insecure) of the farming households was 0.0711, indicating that the food insecurity severity of the respondents was 7.11%. This showed that an average core food insecure household would require about 7.11% of the food insecurity line to the households' food budget in order move out of their severe food insecurity status. It could be inferred from the study that there is existence of food insecurity among the rural households in the study area. This was in conformity with Omotayo (2016) who reported that majority of rural farming households in Nigeria are food insecure.

Table 3: Food insecurity indices among the farming households

Food Insecurity Status	Value
Incidence of Food Insecurity (P_0)	0.4205
Depth food insecure (P_1)	0.1913
Severe food insecure (P_2)	0.0711

Maximum likelihood estimate of Logit regression of the effect of CSA practices on food security status

The result of the logit regression analysis showing the effects of selected socio-economic characteristics of the respondents and CSA practices on the food security status of the respondents (as shown in Table 5). The statistically significant variables affecting the food security status of the farming households were gender of household head ($p<0.1$), farm size ($p<0.01$), contact with extension agent ($p<0.05$), main occupation ($p<0.05$) and CSA practices ($p<0.01$). The gender of household's head was positive (0.1045) and significant ($p<0.1$), implying that a male-headed household had a higher probability of being food secure compared to their female counterparts, and might be due to more males have higher income generating activities. The result was butressed by Rahman *et al*., (2021) who reported that there are more food secure male-headed households than female-headed in Nigeria. In addition, the coefficient of farm size was positve (1.3011) and significant ($p<0.01$). This shows that the larger the farm size of a household the more the likelihood of being food secure. The coefficient of the education status of the household's head was positive (0.1167) and significant ($p<0.05$), which implies that educational level had a higher probability of leading to a food secure status. Education is expected to increase the capacity of farmers to obtain, process and utilize information relevant to the adoption and management of agricultural practices (Onyeneke *et al*., 2018). The coefficient of access to extension service and training was positive (1.0413) and significant ($p<0.05$), implying that an increase in access to extension service increased the likelihood of being food secure.

Furthermore, coefficient of CSA practices was positive (2.0017) and significant ($p<0.05$), imdicating that the more CSA practice, the higher probability of being food secure in the study area. The results imply that CSA adaptation would brighten the chances of farming households in the study area to be food secure. This results agrees with McClement (2019) on study of CSA practices and food security in smallholder production systems in SSA, which reveal that farmers who adopted CSA practices were at a better level of being food secure than non-adopters. The Adjusted R^2 of 0.6275 implies that the explanatory variables explain about 62.75 % of the variations in the logistics regression model of the effect of CSA practices on food security.

Table 4: Logit regression result of the effect of climate smart agricultural practices on food security

Variables	Coefficient	Robust Standard Error	Z	Marginal effect
Constant	-0.1218***	0.1173	-2.4145	-0.0152
Gender	0.1045*	0.0891	1.8871	0.0229
Formal Education	0.1167**	0.0316	1.9409	0.0231
Household size	-0.0021	0.2184	-0.9618	-0.1209
Farm size	1.3011***	0.7101	2.3314	0.0321
Farming experience	-1.0019	0.5331	-0.9928	-0.0318
Farm income	0.0031	0.0346	1.0201	0.0313
Contact with Extension agent	1.0413**	0.1942	1.9903	0.0122
Main occupation	0.1043	0.2813	1.1193	0.0218
CSA Practice	2.0017***	0.5012	2.6711	0.1033
Likelihood =	-157.021			
Pseudo R^2	0.6275			
Chi Square	35.42***			
Number of observation	480			

Note: ***, **, and * represent 1%, 5%, and 10% significance level, respectively

Conclusions and Recommendations

This article focused on various CSA practices in the study area, level of usage and then examined the effects of the level of usage of CSA on household food security. The study revealed that use of climate smart agricultural practices improved the food security status of farming households, with 57.5% of them being food secured and 42.5% being food insecure. Furthermore, crop diversification, crop rotation, planting of drought/heat tolerant crops, intercropping and using organic manure were among the highly accepted CSA practices by the sampled farming households in the study area. The result revealed that mainstreaming CSA into food crop production would impact the livelihood and food security status of small-scale farming households in the study area.

Based on the findings, the study recommends that government and all stakeholders should promote and encourage the adoption of CSAP that will ensure agricultural sustainability in agrarian communities through mitigating the effect of climate change. Also, farmers should be encouraged to diversify their source of livelihood, this will help to adopt the various forms of CSAP without lacking income for the sustenance of their households.

References

Akanbi R T, Davis N and Ndarana T (2021). Climate change and maize production in the Africa: assessment of farmers' awareness, perceptions and adaptation strategies Clim. Res. 82 191–209

Akano O, Modirwa S, Oluwasemire K and Oladele O (2022). Awareness and perception of climate change by smallholder farmers in two agroecological zones of Oyo state Southwest, Nigeria. GeoJournal

Akter S and Ahmed K R (2021). Insight and explore farming adaptation measures to support sustainable development goal 2 in the southwest coastal region of Bangladesh Environ. Dev. Sustain. 23 4358–84

Amare, M., Jensen, N., Shiferaw, B. and Cissé, J. (2018). Rainfall shocks and agricultural productivity: implication for rural household consumption. Agricultural Systems, 166: 79–89;

Brosch T (2021). Affect and emotions as drivers of climate change perception and action: a review Curr. Opin. Behav. Sci. 42 15–21

FAO. (2019). Social protection framework: promoting rural development for all. Rome, FAO

McClements, D.J. (2019). Future foods: How modern science is transforming the way we eat; Springer: 2

Omotayo, A.O. (2016). Farming households' environment, nutrition and health interplay in Southwest, Nigeria. International Journal of Scientific Research in Agricultural Sciences 2016, 3, 84-98.

35 EFFECTS OF LAND TENURIAL SYSTEM ON THE PRODUCTIVITY OF SMALLHOLDER RICE FARMERS IN NASARAWA STATE, NIGERIA

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Abstract

The study examines the effects of land tenurial system on the productivity of smallholder rice farmers in Nasarawa State, Nigeria. Multi-stage sampling technique was used to select 93 respondents on which primary data were elicited from the respondent with the aid of a structured questionnaire complemented with interview schedule. Data were analyzed using descriptive statistics (such as frequency, percentage and mean) and OLS regression. The study revealed that 68.8% of the rice farmers were married, majority (81.3%) had formal education (i.e., primary, secondary, and tertiary), with a mean of 11 years of formal education, 36.6% had access to credit while most (65.6%) of the rice farmers had extension contact and members of society. Inheritance (81.7%) was the major sources of land tenure system in the study area while fertilizer, high yielding seeds, farm size, extension contact and source of land (rent) with coefficient of .0925, 3115, 1.6772, .9112 and 3.3088 respectively were the major factors influencing the productivity of rice output. The study recommends that the land use policy and act should be amended. This is critical in order to facilitate land availability to individual farmers and to mitigate against the dominance of inheritance mode of land acquisition.

Key words: Tenure; productivity; smallholder; rice and effects

INTRODUCTION

Agricultural transformation thrives well when there is a shift from low-productivity and subsistence farming to high-productivity and commercial agriculture. (Olarenwaju, 2016) These changes in turn trigger sweeping structural changes that ripple through the broader economy. At the macro level, agricultural transitions pave the way for economic diversification into services and manufacturing. At the household level, transformation enables agricultural specialization as well as diversification into nonfarm activities (Haggblade and Hazell, 2010). The transformation of agriculture is more than just the marketing of agricultural outputs, though it also involves the substitution of non-traded inputs to traded inputs and the marketing of the household's labour supply. This means that households increasingly base their production and input use decisions on the principles of profit maximization, which increases the strength of the linkage between these households and the market (Jaleta*et al.*,2009). According to Economic Commission for Africa (2004), the concept of 'tenure' is a social construct that defines the relationships between individuals and groups of individuals by which rights and obligations are defined with respect to control and use of land. Payne (2002) defines land tenure as "the mode by which land is held or owned, or the set of relationships among people concerning land or its product". Land tenure plays an important role in the political, economic, social and legal structures of a group of people in particular and a nation in general.

Land tenure relationships may be well defined and enforceable in a formal court of law or through customary structures in a community. Land tenure systems vary greatly among nations, the difference is more glaring especially between developing and developed nations.

Land tenure system has been discussed by many researchers such as Mitchell, (2011); FAO., (2016); Chikaire*et al*., (2017) and Olaniyan*et al.*, (2018). And they laid emphasis on assessing and responding to land tenure issues, analysis of land tenure regimes and rights and so on but only a few researchers like Mahmuda and Tajuddin, (2011) and Idoma and Ismail, (2014) have concentrated on it types and effects of land tenure practices on agricultural output especially in North Central Nigeria. Specifically the study describes the socioeconomic characteristics of rice farmers and examined the effects of land tenure system on the productivity of the rice farmers.

METHOLOGY

The study was carried out in Nasarawa State which is located within the Latitude 8°32'-10°35'N and Longitude 8°18'-11°20'E with annual rainfall varying from 1311.75-1500. The State covers a total land area of 27167 square km with a population of 4,249,679 according to 2006 Population Census.

Multi-stage sampling technique was employed to select 93 respondents for the study. Primary data were elicited from the respondent with the aid of a structured questionnaire complemented with interview schedule. Data collected were analyzed using descriptive statistics (such as mean, frequency distribution count and percentages) and inferential statistics (such as OLS regression). The algebraic specification of the model is given as:

$$Y= (\beta_1 X_1) + e, \qquad (1)$$

TFP = F (FERT, AGCH, HYS, AUTR, MA, HCI, LBR CRED, FSIZE, FEDU, FAGE, EXTN, PLCU, ILCU, RLCU, GLCU) (2)

Where:
TFP = Total Factor Productivity (TFP index)
F = Function of
FERT = Fertilizers (Naira/Kg) , AGCH =Agrochemical (Liters) , HYS = High yielding seeds (Kg)
MA = Market access (Distance in kilometer) , HCI = Household commercialization index
LBR = Labour input (Man-days) , AUTR = Amount spent on use of tractor (Naira)
CRED = Credit in (Amount received in Naira) , FSIZE = Farm size in (Hectare)
FEDU = Formal education (No. of years spent), FAGE = Age of farmer (years)
EXTN = Extension contacts (Number of extension visits), PLCU = Purchased land cultivated (Yes=1 and 0 otherwise), ILCU = Inherited land cultivated (Yes=1 and 0 otherwise), RLCU = Rented land cultivated (Yes=1 and 0 otherwise), GLCU = Gifted land cultivated (Yes=1 and 0 otherwise)

RESULTS AND DISCUSSION

Socioeconomic characteristics of rice farmers

The result in Table 4.1 revealed that most (68.8%) of the rice farmers were married, while 32.2% were not married (i.e., either single, widowed, or divorced). This implies that most of the rice farmers were married with the aim of increasing the household size to help in carrying out farming activities. This is similar to the study of Odoemekun and Anyim (2019) who opined that majority of farmers married for increased household size. Also, the majority (81.3%) of rice farmers in the study area had formal education (i.e., primary, secondary, and tertiary), with a mean of 11 years of formal education. This implies that the majority of rice farmers in the study area had a moderate literacy level, which could help them make better decisions with respect to land acquisition for agricultural purposes. More so, 36.6% of respondents had access to credit; this implies that access to credit in the study was low, which could be attributed to bureaucratic procedures and the inability of small-scale farmers to present collateral to obtain a loan from formal financial institutions.In addition, most (65.6%) of the rice farmers had extension contact; the reason for the high level of extension contact in the study area could be attributed to various interventions and innovative sponsored projects like IFAD and FADAMA, which necessitated that extension agents disseminate the innovations to farmers. Most of the respondents (65.6%) were members of cooperatives; this is expected to help rice farmers in land acquisitions to improve their productivity.

Table 1: Distribution of respondent according to socio-economic status of smallholder rice farmers

Variables	**Frequency**	**Percentage(%)**	**Mean**
Marital status			
Married	64	68.8	
Single	8	8.6	
Widowed	13	14.0	
Divorce	6	6.5	
Separate	2	2.2	
Level of education			
Primary	19	20.4	
Secondary	46	48.5	11
Tertiary	19	20.4	
Adulteducation	9	9.7	
Access to credit	34	36.6	
Extension contact	68	73.1	
Membership of cooperative	61	65.6	

Source: Field survey, 2022

Mode of land acquisition in the study area

The result in Table 2 revealed the mode of land acquisition by rice farmers. The land tenure system affects agricultural land use and prospects for improvement. It was revealed that the major mode of land acquisition in the study area was inheritance (81.7%). This was followed by rent (11.8%), purchase (9.7%), and gift (5.4%). This portrays that land acquisition through inheritance is the most common type of land tenure system in the study area. This negates the study of Omotoso *et al* (21019) who opined that the customary land tenure system is the predominantly practiced tenure system in the South Western Nigeria. The practice of transferring land to children upon the death of a parent is referred to as "inheritance." The land acquired through inheritance is permanent and heritable, and the holder is expected to exercise full control. Although land acquired through inheritance can lead to fragmentation, thereby preventing mechanization, it can also lead to generational problems within the families that have access to such land.

Table 2: Distribution of farmers according to mode of land acquisition in the study area

Variable	Frequency	Percentage(%)
Inheritance	76	81.7
Purchase	9	9.7
Gift	5	5.4
Rent	11	11.8

Source: Field survey, 2022

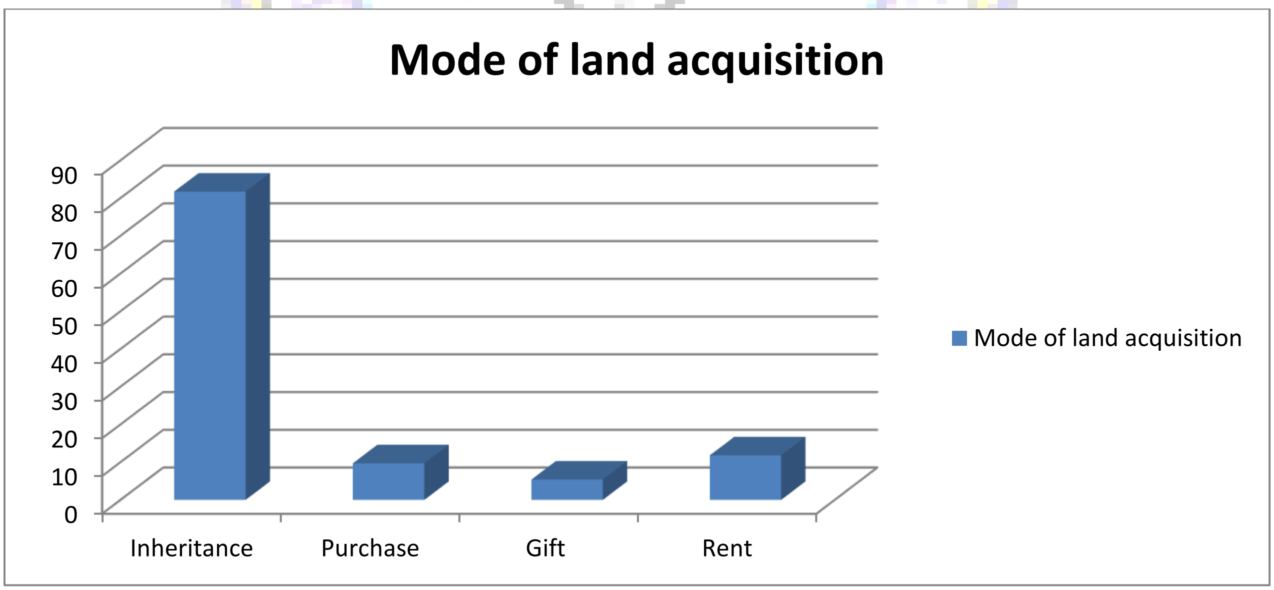

Figure 1: Mode of land acquisition

Effects of land tenure system on the productivity of the rice farmers

The OLS regression estimate result presented in Table 3 revealed coefficient of determination (R^2) value of 0.6462. This implies that approximately about 65% variation in the productivity of smallholder rice farmers were explained by the independent variables included in the model, while the remaining 35% unaccounted variation could be due to error or other variables not captured in the model. The F – ratio is statistically significant at 1% probability level implying the perfect fit of the model and good at predicting the observed data.

The coefficient for fertilizer (.0925) was negative and statistically significant at 1% probability level. This implies that a unit increase in fertilizer usage may decrease the productivity. This is negate the *a priori* expectation, the reason for this results may be due improper application of fertilizer by respondent,

The coefficient of high yielding seeds (0.3115) was positive and significant at 5% probability level. This implies that a unit increase in planting of high yielding seeds may leads to 31% increases in the riceproductivity. The coefficient for farm size (1.6772) was positive and significant at 1% probability level. This implies that a unit increase in farm land may lead to increase in the productivity of rice farms. Also, the coefficient for extension contact (.9112) was negative and statistically significant at 1% probability level. This implies that a unit increase in extension contact may lead to decrease in productivity of rice farm. This negate the expected *a priori*, the reason for this result could be attributed to the fact that despite the high level of extension contacts in the study area, the level of utilization was low due to ratio of extension agent to farmers. More so, the coefficient source of land through rent (3.3088) was negative and statistically significant at 10% probability level. This implies that a unit increase in land rentage may leads to decrease in productivity of rice farm.

Table 3: Regression on the effects of land tenure system on the productivity of the rice farmers

Variables	**Coefficient**	**t-value**
Fertilizer	-.0925***	-5.64
Agrochemical	1560	1.80
High yielding seeds	.3115**	2.10
Market access	1.1015	1.40
Labour	.0001	0.58
Amount spend on tractor hiring	8.80e-06	0.72
Access to credit	-4.08e-06	-0.46
Farm size	1.6772*	1.89
Formal education	.0838	0.54
Age	.1101	1.57
Extension contacts	-.9112***	-3.49
Sources of land Purchase	-2.1934	-0.93
Sources of land Inheritance	1.0123	0.50
Sources of land Rent	-3.3088*	-1.71
Sources of land Gift	2.2356***	3.23
Constant	2.1294	0.46
R-squared	0.6462	
Prob> F	0.0000	

Source: Field survey, 2022

*** = 1% probability level, ** = 5% probability level and * = 10% probability level

Conclusion and recommendation

The study revealed that most of the rice farmers were married and educated with at least secondary education. However, there was poor access to credit, fair contact with extension agents and good cooperative membership. Inheritance was the major sources of land tenure system in the study area while fertilizer, high yielding seeds, farm size, extension contact and source of land (rent) were the major factors influencing the productivity of rice output. The study recommends that The land use policy and act should be amended. This is critical in order to facilitate land availability to individual farmers and to mitigate against the dominance of inheritance mode of land acquisition.

REFERENCE

Chikaire J. U., Nnadi F. N., Ani A. O. &Ukpongson M. A. (2017). Analysis of land tenure regimes and rights among the local farmers of Southeast, *Nigeria. Innovative techniques in agriculture* (1)5 218-226

Economic Commission for Africa (2004). Land tenure systems and their Impacts on food security and sustainable development in frica. ECA. 54–67.

FAO (2016). The State of Food Insecurity in the World 2015. Food and Agriculture Organization of the United Nations. Rome. Retrieved from: http://faostat3.fao.org/ home/E. 03/03/2021.

Haggblade, S. &Hazell, B.R. (2010). *Successes in African Agriculture: Lessons for the Future.* Baltimore: Johns Hopkins University Press. pp28.

Idoma K., & Ismail M., (2014) The effects of land tenure practices on agricultural output in Agatu Local Government Area of Benue State, Nigeria. *Journal of Development and Agricultural Economics*, 6(5), 212-219

Jaleta, M., Gebremedhin, B. & Hoekstra, D. (2009). Smallholder commercialization: Processes, determinants and impact. *Agricultural Economics* 45 (1): 53-67.

Mahmuda, N. &Tajuddin, M. (2011). Land tenure system and agricultural productivity in a selected area of Bangladesh progress. *Agricultural Economics*. 22(1 & 2), 181 – 192.

Mitchell, D. (2011). Assessing and Responding to Land Tenure Issues in Disaster Risk. Management (FAO Land Tenure Manual 3). http://www.fao.org/3/a-i2115e.pdf.

Odoemekun, I. U. & Anyim C. P. (2019). Assessing the factors influencing the utilization of improved cereal crop production technology by small-scale farmers in Nigeria. *Indian Journal of Science and Technology*, 3(1), 180-183.

Olaniyan, J. O., Theophilus, I., Ajala, O. N., Affinnih K. O., Ajibowye, G. & Ahamefule H. E. (2018). Soil property and land use influence on weed occurrence in the Southern Guinea Savanna of Nigeria. *Albanian Journal of Agricultural Science.* (17)1, 13-22.

Olarenwaju, E. (2016). Agricultural commercialization: Effect on food security among smallholder farming households in south-western Nigeria. *International Journal of Science and Research (IJSR)*, 5 (11), 65-69

Payne G. (2002) Land, rights and innovation: Improving tenure security for the urban poor. Intermediate Technology Development Group. 2002.

ANIMAL SCIENCE/PRODUCTION

36 EFFECT OF DIFFERENT PROCESSING METHODS ON NUTRIENTS AND ANTI-NUTRIENT COMPOSITION OF LEUCAENA (*Leucaena leucocephala*) SEEDS

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Abstract

Effect of different processing methods on proximate and anti-nutrient composition of Leucaena leucocephala seeds was carried out. Three different processing methods (boiling, sprouting and roasting) were carried out. All the processed seeds were milled, labelled and taken to the laboratory for proximate and phyto-chemical analysis. Results of the study revealed that processing significantly influenced (P<0.05) all the proximate and anti-nutritional contents determined. Raw Leucaena leucocephala seeds contain 94.12 % dry matter, 4.46 % ash, 39.74 % crude protein, very low in crude fibre (6.89 %), 12.73 % ether extract, 30.31 % and nitrogen free extract. Boiling, 8.48 %, roasting, 8.32 % and sprouting, 8.25 %, significantly increased the fibre content of the seeds. Anti-nutritional factors were significantly (P<0.05) influenced by the processing methods. Raw seeds were found to contain high anti-nutritional factors (Phytate, 6.30 mg/ 100g and saponin, 8.56 mg/ 100g). Raw and roasted seeds had similar high content of tannin (raw, 4.25 mg/ 100g and roasted, 3.87 mg/ 100g). The roasted seeds were high in oxalate contents (11.34 mg/ 100 g). It was concluded that Leucaena leucocephala seeds should be improved by processing before being used as livestock feed.

Key words: Proximate and anti- nutritional factors, processing methods, raw, toasted and boiled *Leucaena leucocephala* seeds.

INTRODUCTION

Nigeria possesses a great deal of vegetation that is adequate to produce animal feed. However, there is serious inadequacy of animal protein production in Nigeria, this is because of high cost of feed occasioned by the use of conventional feed stuff. Over a period of time, commercial poultry farmers have increased universally; however, the demand for animal protein is still far higher than the supply, hence, animal protein is expensive especially in developing countries. The high cost of animal protein has made it unaffordable for the average Nigerian man (Ani and Adiegwu, 2005). Feed and feeding represents 70 to 80 % of the total variable cost of monogastric feed. This is due to the usage of conventional feed stuffs (maize, groundnut cake and soya beans) which are in demand by man for food and industries. This has led to prolonged competition for feed ingredients between the poultry industry and the human population. Therefore, to reduce this problem, several researchers have recommended the use of nonconventional feedstuffs in poultry nutrition. There are many nonconventional feeds or agricultural by-products with substantial nutritional value and are inexpensively available in large quantities. Presently, only a small number are in use either due to lack of adequate nutritional information, for other purposes, or presence of some deleterious constituents like alkaloids, toxic amino acids, phenolic compounds, tannins, trypsin inhibitors, carcinogens and glucosinolates. Various sources of agricultural by products and their nutritional characteristics have been reviewed, this is because of high cost of feed occasioned by use of conventional feed stuff (Nuha *et al.*, 2010). However, there are limited information on the effect of different processing methods on proximate and ant-nutritional contents of *Leucaena leucocephala*. Therefore, this study is aimed at determining the effect of different processing methods on proximate and ant-nutritional contents of *Leucaena leucocephala.*

MATERIALS AND METHODS

Experimental site

The research work was conducted at the Teaching and Research Farm of the Department of Animal Production, Federal University of Technology, Bosso Campus, Minna, Niger State, Nigeria. Minna lies between latitude 9^0 28′ to 9^0 37′ N and longitude 6^0 23′ to 6^0 33′ E with annual rainfall of 1000 – 1500 mm and a temperature range of 28^{0-} 30 ^{0}CThe mean annual rain fall varies from 1102.6 to 1361.7 mm (FUTMIN, 2018).

Sample collection and methods of processing

Leucaena leucocephala pods were harvested along the road side in Minna, Niger State. The pods were opened and the seeds were gathered and sorted to remove dirts and stones. The seeds were divided into batches and processed through the following methods: Roasting, Boiling and Sprouting:

Sprouting

The method of processing by Echendu *et al.* (2009) was used. Five kg of *Leucaena leucocephala* seeds was soaked for 24 hours and covered in a moist jute bag. They were moistened daily until they shot out. The sprouted seeds were packed and sun-dried to a moisture level of about 10 – 15 % .The sun-dried seeds were milled and labelled Sprouted Leucaena seed meal (SLSM). They were stored in a plastic air-tight container or leather to prevent it from getting spoilt from air and moisture until when required. The method of processing raw and sprouted seeds by Madubuike *et al*. (2003) could also be used. Five kg of legume seeds were cleaned by picking of dirt and washing with water then sun-dried to a moisture level of about 10 – 15 % .The sun-dried seeds were milled and labeled Raw Leucaena seed meal (R-LSM).

Toasting

Five kg of Leucaena seed was roasted at 100^0 C for 30 minutes using stove with iron pot mixed with sand as described by Sola-ojo *et al*. (2013). During toasting, the seeds were stirred continuously to ensure uniform toasting and to prevent burning until they turned brown. The toasted seeds were then spread out to cool after which they were milled using a hammer mill with sieve size of 3 mm and labelled Toasted Leucaena seed meal (TLSM).

Boiling

Another five kg of Leucaena seed was subjected to boiling at 100^0 C for 15- 30 minutes as described by Ahamefule *et al*. (2008) after which water was drained off by means of a 10 mm sieve and the boiled seeds were sun -dried. The seeds were then milled using hammer mill and then sieved with a 3mm sieve size and labeled Boiled Leucaena seed meal (BLSM).

All the samples were stored in a plastic air-tight container to prevent them from getting spoilt from air and moisture until when required.

All the processed samples were subjected to laboratory analysis in triplicate to determine the proximate, energy and anti-nutrient contents according to the method of AOAC (2006), at the Animal Science Laboratory, Federal University of Technology, Minna.

Data Analysis

Data generated were subjected to Analysis of variance (ANOVA) using the general linear model of statistical analysis system, Version 9.3 (SAS). Significance was accepted at P <0.05.

RESULTS AND DISCUSSION

The proximate and energy values result of differently processed *Leucaena leucocephala* seeds meal is presented in Table 1. All the parameters measured were influenced (P<0.05). Raw *Leucaena leucocephala* seeds meal had higher (P<0.05) dry matter, ash, crude protein, ether extract and energy The toasted seed meal had higher (P<0.05) dry matter, ash, crude fibre, ether extract and energy when compared with the other treatment. Sprouted *Leucaena* seed meal treatment had lower (P<0.05) dry matter, ether extract and energy among all the treatment and control. Raw legumes are reported to have higher nutritional contents when compared to most treated ones Seena *et al.* (2005) in wild legume; Adekojo *et al.* (2014) in *Leucaena* leaves meal. This is because treatments alter some of the nutrients in the legumes. The dry matter value of 92.44 % observed in this study was lower than 93.50 % dry matter as reported by Michael *et al.*, (2019) in their study on *Jatropha curcas* seed meals. They were, however, significantly different (P<0.05). The crude protein contents ranged between 30.62 – 39.74 %, the crude protein value of 35.23 % boiled seeds in this study was higher than 34.82 % as reported by Wafar *et al*. (2018) in boiled *Kapok* seed meals, while the crude protein value of 39.74 % in raw seeds observed in this study was higher than 37.69 % as reported by Ogbemudia *et al.* (2017) on mineral and proximate composition of soya bean seeds. The crude protein value of 30.62 % in toasted seeds observed in this study was similar 30.46 % as reported by Michael *et al.* (2019) in toasted *Jatropha curcas* seed meals. The ether extract value of 6.89 % in toasted seeds observed in this study was similar to 6.75 % as reported by Michael *et al.* (2019) in toasted *Jatropha* seed meals. They were, however, all significantly different (P<0.05) from one another.

Results on the effects of processing on the anti- nutritional factors of *Leucaena leucocephala* seeds are presented on Table 2. The results revealed that all the parameters measured were influenced (P<0.05) by processing. Phytate, tannin and saponin contents were highest (P<0.05) in the raw *Leucaena leucocephala* seeds. While boiled treatment led to higher (P<0.005) reduction of phytate (32.06 %), tannin (62.97 %) and saponin when compared with the raw. The sprouted treated method was next to the boiled processing method. Toasting had the least reduction method. Oxalate contents were highest (P<0.05) in the toasted seeds, with a higher (P<0.005) in sprouted seeds. There was no (P>0.05) difference in the tannin contents of the toasted *Leucaena leucocephala* seed meal when compared to the raw. However, the higher percentage reduction of all parameters observed in boiling in this study confirms with the reports of Saulawa *et al*. (2014)

and McEwan *et al*. (2014) who reported that boiling method was very effective in reducing anti-nutrients in baobab (*Adansonia digitata)* and Amadumbe (*colocasia esculenta*), respectively when compared to other processing methods. The apparent decrease in the content of phytates during boiling may be partly due to heat hydrolysis or leaching into the boiling medium or by the formation of insoluble complexes between phytates and other components such as phytate-proteins and phytate-protein-mineral complexes has reported by Mohammed *et al*. (2011). Reduction of phytate is expected to enhance the bioavailability of proteins and dietary minerals of the seeds. All the anti- nutrient parameters observed in this study for raw seeds differ from what was reported by Poonam and Pushpa (2009) who observed that low tannin content of 1.2 %. The variations could be due to reasons reported by Ann and Neema (1982) that species may vary not only in composition of nutrient but in type and amount of toxins based on location.

Table1. Proximate composition of *Leucaena leucocephala*

Analysis	RLSM	BLSM	SLSM	TLSM	SEM	P-Value
Dry matter	94.12^{a}	86.19^{c}	79.32^{d}	88.44^{b}	2.004	0.001
Ash	4.46^{a}	3.49^{d}	3.61^{c}	4.11^{b}	0.147	0.001
Crude Protein	39.74^{a}	35.23^{b}	31.52^{c}	30.62^{d}	1.36	0.001
Crude Fibre	6.89^{c}	8.48^{a}	8.25^{b}	8.32^{b}	0.241	0.001
Ether Extract	12.73^{a}	10.61^{c}	8.91^{d}	12.44^{b}	0.581	0.001
Nitro. Free Extract	30.31^{b}	28.38^{c}	27.02^{d}	32.96^{a}	0.844	0.001
Energy	3.95^{a}	3.50^{c}	3.14^{d}	3.66^{b}	10.99	0.001

*All values are means of triplicate determinations expressed in dry weight basis, a,b,c,d=means with different superscripts on the same row are significantly different (P<0.05), RLSM – Raw Leucaena seed meal, BLSM – Boiled Leucaena seed meal, SLSM- Sprouted Leucaena seed meal, TLSM- Toasted Leucaena seed meal. SEM=Standard error mean, P=Probability value.

Table2. Anti-nutritional composition of Leucaena leucocephala

Treatment	RLS	BLSM	SLSM	TLSM	SEM	P-Value
Phytate	6.30^{a}	2.39^{d}	3.91^{c}	5.62^{b}	0.58	0.001
Saponin	8.56^{a}	3.17^{d}	4.18^{c}	7.31^{b}	0.83	0.001
Tannin	4.25^{a}	1.24^{c}	2.54^{b}	3.87^{a}	0.45	0.001
Oxalate	8.45^{c}	9.65^{b}	7.84^{d}	11.34^{a}	0.51	0.001

*All values are means of triplicate determinations expressed in dry weight basis, a,b,c,d=means with different superscripts on the same row are significantly different (P<0.05), RLSM – Raw Leucaena seed meal, BLSM – Boiled Leucaena seed meal, SLSM- Sprouted Leucaena seed meal, TLSM- Toasted Leucaena seed meal. SEM=Standard error mean, P=Probability value.

CONCLUSION

Results from this study revealed that the proximate and phytochemical compositions of raw and differently processed *Leucaena leucocephala* seeds differ significantly (P<0.05). The processed seeds were found to contain higher contents of crude fibre (boiled). The anti-nutrients were significantly reduced with processing, raw *leucaena* had higher anti-nutritional content. Among the treated, the boiling method had the highest anti-nutrition reduction.

REFERENCES

Adekojo, S.A., Adama, T.Z., Aremu, A., & Ijaiya. A.T (2014). Effects of Different Methods of Processing *Leucaena leucocephala* Leaf Meal on Growth Performance and Nutrient Digestibility of Rabbits. *International Journal of Agriculture and Forestry,* 4(5); 380-385.

Ahamefule, F.O., Obua, B.E., Ukweni, I.A & Amaka, R.A. (2008).Haematological and Biochemical Profile of Weaner Rabbits fed Raw or Processed pigeon pea seed Meal based diets. *African Journal of Agricultural Research*,3(4): 315-319.

Ani, A. O & Adiegwu, L. I (2005). The Feeding value of velvet beans (Mucuna pruriens) to weaner rabbit. *Proceedings of the 30th Annual Conference of Nigerian Society for Animal Production.* University of Nigeria Nsukka, Nigeria. pp.186 -189.

Ann, F.W & Neema, K. (1982). Effect of processing including domestic cooking on nutritional quality of legumes. *Proceeding of Nutrition Society,* 4-51. AOAC(2006).Official Methods of Annalyses. (18thed.) National Research Council, Washington D. C. National Academy Press.

AOAC (2006). Official Methods of Analyses. (18thed.) National Research Council,Washington D. C. National Academy Press.

Echendu, C. A., Obizoba, I.C., Anyika, J.U & Philippa, O (2009). Changes in Chemical Composition of Treated and Untreated Hungry Rice “Acha” (*Digitaria exilis*). *Parkistan Journal of Nutrition,* 8(11):1779 -1785.Doi:10.3923/pjn.

FUTMIN, (2018). Postgraduate School. prospectus. Federal University of Technology Minna, Nigeria State.

Madubuike, F.N., Agiang, E.A., Ekenyem, B.U., Ahaotu, E.O (2003). Replacement value of rubber seed cake on performance of starter broiler. Journal of Agriculture and Food Science. 1:21-27.

Mc Ewan, R., Shangase, F. N., Djarova, T., & Opoku, A. R(2014). Effect of three processing methods on Some utrients and anti-nutritional factor constituents of *Colocasia esculentus* (Amadumbe). *Afrcan Journal of Food Science,* 8,286 -291.

Michael, K. G., Sogbesan, O. A., Onyia, L.U & Shallangwa, S.M (2019).Nutritional Evaluation of processed *Jatropha carcus* seed meals. *Direct Research Journals of Agriculture and Food Science* (DRJAFS). 7 (6): 131-136. ISSN: 2354-4147. Doi: https// doi.org/ 10.5281/ Zenodo.3242756.

Mohammed, K.R., Abou-Arab, E.A., Gibriel, A.Y., Rasmy, N.M., & Abu-salem, F.M. (2011).Effect of legume processing treatments individually or in combination of their phytic acid content. *African Journal Food Science and Technology*, 2, 36-46.

Nuha, M. O., Isa, A. M. A & Elfadil (2010). Chemical Composition, anti- nutrients and extractable minerals of sickle pod (*Cassia obtusifolia)* leaves as influenced by fermentation and cooking. *International Food Research Journal*. 17: 775-785.

Ogbemudia, R. E., Nnadocie, B.C & Anuge, B (2017). Mineral and Proximate Composition of Soya bean. *Asian Journal of Physical and chemical Sciences*.4 (3): 1 – 6. Article no. AJ0PACS. 38530.ISSN: 2456 -7779.

Poonam, S & Pushpa, R.K. (2009). A Nutritional Profile. Chemical Composition of Leucaena leucocephala seeds. *International Journal of Food Science and Nutrition*, 45(1):5-13.

Saulawa, L. A., Yaradua, A. I & Shuaibu, L (2014). Effect of different processing methods on proximate, Mineral and anti-nutritional factors content of baobab (*Adansonia digitata*) seeds. *Pakistan Journal of Nutrition*. 13(6):314-318.

Seena, S., Sridhar, K. R & Bhagya, B (2005). Biochemical and Biological evaluation of an unconventional legume *Canavalia maritime* of coastal sand dumes of India. Tropical and subtropical Agrocosystems.5: 1-14.

Sola-ojo, F.E., Adeyemi, K.D., Toye, A.A., Bolu, S.A., Fayeye, T.R., Annogu, A.A., Garba,S.O & Karim, R.O (2013). Performance, carcass profile and oxidative stability of broiler chickens fed baobab seed meal. *Bulletin of Environment, Pharmacology and Life* Sciences.2 (11):94-99.

Wafar, R.J., Yakubu, B., Yusuf, H.B and Antyev, M (2018). Effect of Feeding Raw and Differently Processed Kpakok (*Ceiba pentandra*) Seed Meal on the Growth Performance and Carcass characteristics of Weaner Rabbits. *Nigerian Journal of Animal Science*.20 (2): 258-270.

37 PERFORMANCE OF ARBOR ACRE BROILER CHICKENS FED DIET ENRICHED WITH VARYING LEVELS OF NANO ZINC SUPPLEMENTATION AT FINISHER PHASE

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Abstract
Three weeks feeding trial was conducted to determine the effect of nano zinc supplementation on growth performance and nutrients digestibility of broiler chickens aged four weeks. Three hundred and twenty Arbor Acre broiler chicks were randomly distributed into sixteen treatments with four replicates consisting of five birds per replicates in a completely randomized design on 4×4 factorial combinations. Birds were reared on deep litter and fed basal diets supplemented with varying levels of nano zinc for 21 days. Data obtained were analyzed using Statistical Package for Social Science (SPSS version 16.0). Results showed that total feed intake and daily feed intake were significantly ($P<0.05$) influenced amongst the growth parameters and CP, CF and Ash digestibility were improved. Based on growth and nutrient digestibility performance;dietary supplementation of nano zinc at 30 mg/kg NZn supplemented diet improved feed efficiency and nutrients digestibility of broiler chickens without negative effect on their growth performance and therefore, recommending that farmers can use nano zinc as a source of feed additive to boost birds' growth performance.

Key words: Nano Zinc, Supplementation, Growth, Nutrient digestibility and Broiler chickens

Introduction

Micro minerals are very essential in poultry nutrition for optimal productive performance (Haiam *et al*., 2020). Zinc (Zn) is required for the normal functioning of the animal body, it plays crucial role as cofactor of more than 300 enzymes, structural and regulatory functions in antioxidant and immune system, nucleic acid synthesis, cell proliferation, protein synthesis, protein and carbohydrate metabolism, and enzymatic activities in the living system (Fayiz *et al*., 2021). National Research Council (1994) recommended 30 mg of Zn/kg for broiler chickens; this might not be adequate to support maximum performance as reported by Du *et al*. (2007). Recently, the indiscriminate used of zinc in the diets for optimal productivity, causing public concern due to environmental pollution exerted by minerals excretion. With the emergence of nanotechnology, nano zinc can be incorporated in a nano form as a feed supplement to improve the efficiency of trace minerals in broiler chickens (Geetha*et al*., 2020).The nano-sized particles have higher potential than the conventional with very high surface area to volume ratio enables nanoparticles to be effective in very small amounts and absorbable more quickly than inorganic and organic minerals (Sawosz *et al*., 2009). The aim of this experiment was to evaluate the influence of dietary nano zinc oxide supplementation on growth performance and nutrients digestibility of finished Arbor Acre broiler chickens.

Materials and Methods

Experimental site

The experiment was carried out at the Poultry Unit of the Teaching and Research Farm of the Department of Animal Production, School of Agriculture and Agricultural Technology, Federal University of Technology, Minna, Niger State, Nigeria.

Source of materials

The feed ingredients maize and soybean were purchased from Gidan Matasa and step by step Agro store, Western bypass, Minna. Zinc nitrate $Zn(NO_3)_2$, Sodium hydroxide (NaOH), were bought from Pan lac laboratory equipment and chemicals store, Keteren gwari, Minna. The Africa scent leave (*Ocimun gratissimum*) was sourced from olericulture garden FUT, Minna. All other reagents and equipment used were obtained from the Step 'B' Drug and Vaccine Discovery Laboratory, Bosso Campus, Federal University of Technology, Minna. The green synthesis of nano zinc wascarried out at the abovelaboratory in line with the method described by Jay and Shafkat (2018). Experimental diet was formulated in line with nutrients requirement recommended for finisher broiler chickens (NRC, 1994), as shown in Table 1 below.

Experimental animals, management and design

Broiler chicks were sourced from Yammfy Farm hatchery, Ilemona, Kwara state. Three hundred and twenty (320), day old broiler chicks of Arbor Acre strain were randomly assigned to (4 x 4) factorial arrangements in a completely randomized design having 16 treatments with five birds per replicate. Birds were reared on deep litter and all management's practices suggested for broiler production were strictly observed.

Data collection and statistical analysis

Data collected on growth performance and nutrients digestibility were subjected to 4×4 factorial design using General Linear Model (GLM) procedure of the Statistical Package for Social Science (SPSS version 16.0). Significant means variations were separated using Duncan multiple range test of the same package

Results and discussion

Table 2 revealed that all parameters measured were not significantly ($P>0.05$) affected by the test ingredient except total feed consumed and daily feed consumed. Results indicated that birds fed 20 mg/kg NZn supplemented diet had higher total and daily feed intake than their counterparts. This might be due to variation in the dietary levels of nano zinc supplementation. The present study agreed with the observation of Zhao *et al*. (2014) reported improvement in the feed intake of broiler chickens fed diets supplemented with zinc oxide nanoparticles. Table 3 Showed that crude protein, crude fibre and ash digestibility contents were significantly ($P<0.05$) influenced by nano zinc supplementation. Generally, ZN aids digestive enzymes that catalyzed the breaking down of protein in the digestive tract. Results indicated that CP and CF in birds on 30 mg/kg NZn supplemented diet had higher ($P<0.05$) values than those from 20 mg/kg NZn supplemented diet. This might mean 30 mg/kg impact higher protein digestibility. This could be the reason Kumar *et al*. (2021) observed low level of the CP in the faecal output of birds fed NZn when compared to other treatments.

Table 1: Ingredients composition of the experimental diets (as fed)

Ingredients %	Finisher phase
Maize	55.00
Soybean cake	26.00
Fish meal	3.00
Wheat offal	11.00
Palm oil	1.00
Limestone powder	1.00
Bone meal	2.00
Salt	0.25
Lysine	0.25
Methionine	0.25
Premix	0.25
Total weight (kg)	100.00
Calculated analysis	
Crude protein (%)	20.00
Crude fibre (%)	5.53
Ether extract (%)	5.55
Ca (%)	1.11
Avail P (%)	0.58
ME (kcal/kg)	3000.00

Premix supplied per Kg of diet: Vit. A, 2.5iu;Vit D3, 0.5iu; Vit E, 0.0057mg; Vit. K, 0.0005mg; Vit, B1, 0.00045mg; Vit B2, 0,0013mg; pantothenic acid, 0.0018mg; Vit. B12, 0.000005mg; Folic acid, 0.00018mg; Biotin, 0.000015mg; Choline chloride, 0.075mg; Cobalt, 0.00005mg; Copper, 0.00075mg; Iodine, 0.00025mg; Iron, 0.0025mg; Manganese, 0.01mg; Selenium, 0.00005mg; Zinc, 0.0075mg; Antioxidant, 0.00031mg

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Table 2: Effect of dietary nano zinc oxide supplementation on growth performance of arbor acre broiler chickens (28 - 49 d)

Levels of nano zinc (mg/kg)	Initial body weight (g/b)	Final body weight (g/b)	Total weight gain (g/b)	Daily body weight gain (g/b)	Total feed consumed (g/b)	Daily feed consumed (g/b)	FCR
20	970.93	2199.62	1228.72	58.50	2621.84^{a}	124.85^{a}	2.18
30	968.86	2208.18	1239.21	59.01	2460.91^{d}	117.19^{d}	2.01
40	969.56	2172.65	1203.19	57.28	2507.32^{c}	119.39^{c}	2.13
50	980.76	2188.60	1207.83	57.51	2518.46^{b}	119.92^{b}	2.11
SEM	11.49	54.42	55.32	1.86	5.21	0.17	0.06
P-value	0.70	0.92	0.90	0.90	0.01	0.01	0.59

abcd = means in the same column with vary superscript differs significantly (P<0.05).

Table 3: Effect of dietary nano zinc oxide supplementation on nutrients digestibility of arbor acre broiler chickens (28 - 49 d)

Levels of nano zinc (mg/kg)	CP (%)	DM (%)	CF (%)	EE (%)	ASH (%)	NFE (%)
20	80.06^{b}	86.84	76.98^{b}	81.66	78.92^{ab}	79.68
30	86.23^{a}	85.50	83.79^{a}	83.06	81.20^{ab}	84.94
40	83.87^{ab}	89.70	80.68^{ab}	84.41	77.14^{b}	82.99
50	84.81^{ab}	88.77	81.34^{ab}	83.09	81.84^{a}	85.11
SEM	1.56	1.70	1.62	1.95	1.38	1.86
P-value	0.03	0.31	0.04	0.80	0.04	0.16

ab = means in the same column with vary superscript differs significantly ($P<0.05$).
DM = dry matter, CF = crude fibre, CP = crude protein, EE = ether extract and NFE = Nitrogen Free Extract.
SEM = standard error of mean
P –value = probability levels
mg = milligram and Kg = kilogram % = percentage

The current study concord with Saleh *et al*. (2012) indicated improvement in crude fibre and crude protein digestibility of broiler chickens fed diets supplemented with zinc (0, 20, 40, 60 and 90 mg/kg). Ash demonstrated that birds on 50 mg/kg NZn supplemented diet had higher ($P<0.05$) ash digestibility values than those from 40 mg/kg NZn supplemented diet. This agreed with the observation of Saleh *et al*. (2012) who reported enhanced ash utilization in broiler chickens from dietary supplementation of zinc oxide.

Conclusions and recommendations

Based on the results obtained from the present study, it was evidenced that dietary supplementation of NZn to Arbor acre broiler chickens influenced total and daily feed intake. Crude protein and fibre digestibility were also affected by the dietary treatments. For improve performance and digestibility 30 mg/kg of NZn is recommended for Arbor acre broiler chickens.

References

Du, L., Jiang, H., Liu, X. & Wang E. (2007) Biosynthesis of gold nanoparticles assisted by Escherichia coli DH5a and its application on direct electrochemistry of haemoglobin. Electrochemistry Communications, 9, 1165-1170.

Fayiz, M. R. , Mohamed, T. E., Talaat, K. E., Adel, I. A., Sabry, A. A. E., Sarah, Y. A. A., Mahmoud, M. & Mahmoud, A. (2021). Use of biological nano zinc as a feed additive in quail nutrition: biosynthesis, antimicrobial activity and its effect on growth, feed utilization, blood metabolites and intestinal microbiota. *Italian Journal of Animal Science*, 20:1, 324-335.

Geetha, K., Chellapandian, M., Arulnathan, N. & Ramanathan A. (2020). Nano zinc oxide - an alternate zinc supplement for livestock. *Veterinary World*, 13(1):121–126.

Haiam, S. A., Faten, A. M. Attia, Saber, H. S. & Hermes, I. H. (2020). Impacts of Zinc Oxide Nano-Particles Supplementation in Broiler Diets on Growth Performance, Some Carcass Characteristics and Immune Organs.*Egyptian Journal of Nutrition and Feeds*, 23 (1): 113-122.

Jay, V & Shafkat, R. (2018). Biosynthesis of Selenium Nanoparticles using Aloe vera Leaf Extract.

International Journal of Advance Research, 6 (1), 104-110.

Kumar, A., Hosseindoust, A., Kim, M., Kim, K., Choi, Y., Lee, S., Lee, J., Cho, H., Kang, W. S., & Chae, B. (2021). Nano-sized Zinc in Broiler Chickens: Effects on Growth Performance, Zinc Concentration in Organs, and Intestinal Morphology. *The journal of poultry science*, 58 (1), 21–29.

National Research Council. (1994). Nutrient Requirements of Poultry, 9th ed. Natl. Acad. Press, Washington, DC. 10.

Saleh A. A., Eid, Y. Z., Ohtsuka, A. & Hayashi, K. (2012). Feeding Aspergillus awamori reduces skeletal muscle protein breakdown and stimulates growth in broilers. *Journal of Animal Science*,. 83, 594 – 598.

Sawosz, E., Grodzik, M., Zielin´ska, M., Niemiec, T., Olszan´ska, B. & Chwalibog, A. (2009). Nanoparticles of silver do not affect growth, development and DNA oxidative damage in chicken embryos. Archiv fur Geflugelkunde, 73, 208-213.

`Zhao, C. Y., Tan, S. X., Xiao, X. Y., Qiu, X. S., Pan, J. Q. & Tang, Z. X. (2014). Effects of dietary zinc oxide nanoparticles on growth performance and anti-oxidative status in broilers. *Journal of Biology Trace Element Research*, 3, 361-367.

38 DIVERSITY AND COMPOSITION OF UNDERSTORY SPECIES IN *Cedrela odorata* AND *Pinus caribaea* PLANTATIONS IN OMO BIOSPHERE RESERVE, AREA J4, OGUN STATE

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Abstract
Plantation, as a part of terrestrial ecosystem, is of immense value for their production and protection potential. The study on the diversity of understory species in Cedrela odorata and Pinus caribaea plantation was carried out in Ogun State Forestry Plantation Project, Area J4, Ogun state. Twenty plots of 2 m x 2 m quadrants were laid randomly in each of the plantation to enumerate the understory composition, density, frequency, relative density, relative frequency and important value index. Similarity and diversity statistics were used to analyse the data in PAST version3 software. A total density of 192,750 individuals/ha from 71 species from 37 families in Cedrela odorata plantation and 136,000 individuals/ha of 43 species from 30 families in Pinus caribaea plantation was recorded. Species common to both plantations include Abrus precatorius, Albizia zygia, Baphia nitida, Canthium subcordatum, Carpolobia alba, Chromolena odorata, Cnestis ferugia, and Combretum platypterum The species dominance was higher in Pinus caribaea (0.05) than in Cedrela odorata (0.03), diversity was higher in Cedrela odorata (0.97) than in Pinus caribaea and Species similarity between the two stands is 53%. The abundance of species of Leguminosae, Euphorbiaceae, Poaceae, Apocynaceae may indicate that seedlings/saplings of these families contributed greatly to the composition of the understory in the forest floor. The presence of abundance of some species like Cedrela odorata, Chromolena odorata, Discorea bulbifera, Baphia nitida in nearly all the plots and their high density in the entire study area may indicate their wider range of ecological adaptation. Cedrela odorata plantation was typically richer in species composition than the Pinus caribaea plantation, this is evident in their number of species present and density/ha of the total species in each of the site (71 species; 192,750/ha) and (43 species; 136,000/ha) respectively. Conclusively, Cedrela odorata and Pinus caribaea plantation supports regeneration of the native and a productive plant community.

Keywords: *Cedrela odorata, Pinus caribaea, Understory, Diversity, Similarity, Importance Value Index*

Introduction
Plantation, as a part of terrestrial ecosystem, is of immense value for their production and protection potential. They usually include exotic species or native species or native species typically forming extensive pure stands. There is a common belief that the managed forests negatively influence biodiversity, but recent studies (Parrotta, 1995; Viisteensari *et al*., 2000; Yirdaw, 2001) have shown that they can help in enhancing the recruitment, establishment and succession of native woody species by functioning as foster ecosystems as they stabilize the soil and create conditions favourable for native animals and plants to re-colonize (Parrotta, 1995;

Yirdaw, 2002). Plantations are established for a variety of purposes including wood production, soil and water conservation, carbon sequestration. In many parts of the world, plantation also play a key role in restoring local ecosystem services and by reducing runoff and erosion on previously degraded sites (Lugo, 1997, Christian *et al*., 1998, Ratsirarson *et al* 2002). Despite these positive attributes, plantation forests are widely viewed in a negative light in relation to biological diversity conservation, especially when intensive monocultures of exotic species are involved (Carnus, *et al.,* 2003). However, many understory species may affect the development of overstory species at seedling stage by regulating nutrient cycles, modifying climatic conditions, or competing for site resources (Kimmins, 1987; Gilliam and Tunill, 1993; George and Bazzaz, 1999; Tremblay and Larocque, 2001). Therefore, this study is aimed at identifying important understory species and to provide a quantitative description of the structure and floristic composition of understory species in *Cedrela odorata* and *Pinus caribaea* plantations in Omo Biosphere Reserve, Area J4, Ogun state.

Materials and Methods

The study area

The plantation used is *Cedrela odorata* and *Pinus caribaea* plantation in Ogun state Forestry Plantation Project, Area J4, Ogun state.Omo Biosphere Reserve is located between latitudes 6^0 35^1 to 7^0 05^1 N and longitudes 4^0 19^1 to 4^0 10^1 E in the Ijebu area of Ogun state (Badejo and Ola-Adams, 2000); about 135 km north-east of Lagos, about 120 km east of Abeokuta and about 80 km east of Ijebu Ode (Ola-Adams, 1999). The reserve shares a common boundary in its northern part with two other forest reserves-Ago Owu and Shasha in Osun state. It also has a common eastern boundary with Oluwa Forest Reserve in Ondo state (Karimu, 1999). It covers 130,500 hectares of land. The reserve falls within the tropical wet-and-dry climate characterized by two rainfall peaks separated by a relatively less humid period usually in the month of August. The mean annual rainfall is about 1750mm and the mean relative humidity is 80%, sunshine duration during the rainy season varies between 8-10 hours (Oladoye et al., 2018)

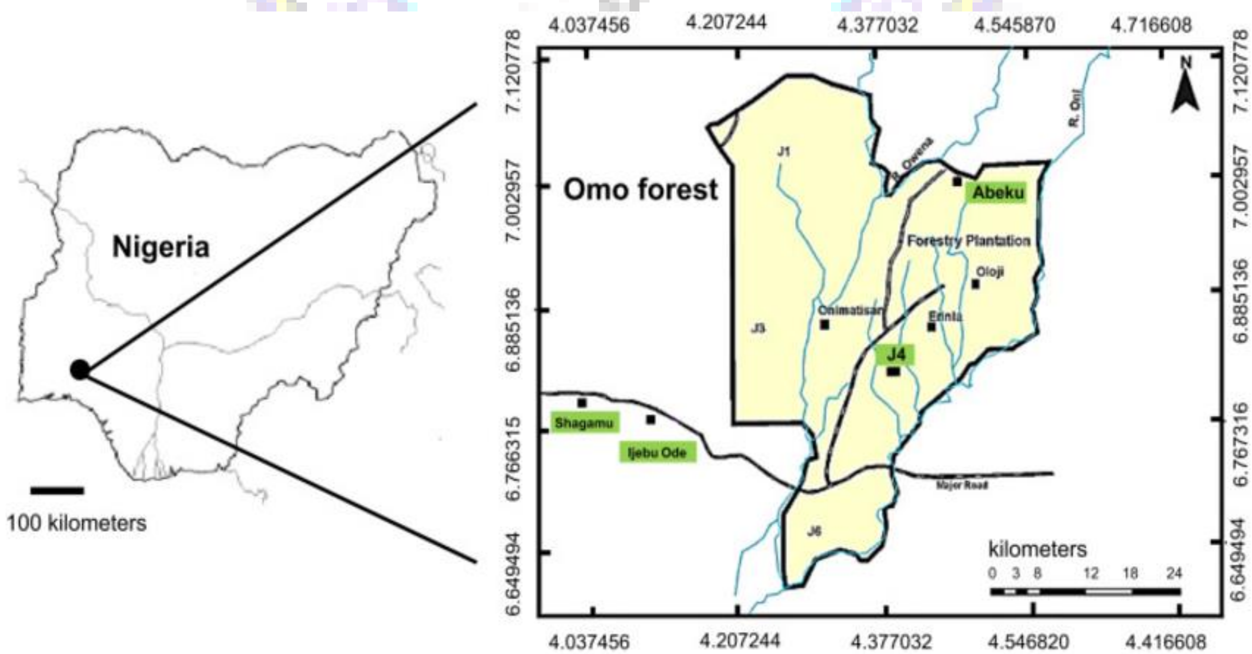

Figure 1: Map showing the study area

Data Collection

. Twenty plots of 2 m by 2 m quadrant were laid randomly on each of the plantations (*Cedrela odorata* and *Pinus caribaea* plantation). Species present in each of the quadrant were counted and identified. Species that could not be identified on the field were collected and taken to the herbarium of The University of Agriculture and Forestry Research Institute of Nigeria for proper identification.

Data Analysis

. Density, relative density, important value index was calculated according to the formulae of Dumbos-Muller and Ellenberg, 1974, Oladoye, 2013, 2014, using the corresponding equations below:

Density = …………………………………………...Equation (1)

Frequency = x 100 …………………Equation (2)

Relative density (RD)= x 100 ……………………….....Equation (3)

Relative frequency = x 100 ………………………..Equation (4)

Important value index (IVI) = (Relative density + Relative frequency) ……..Equation (5)

Density/Ha = x 100 ………………………………………..Equation (6)

Species diversity analysis

Simpson diversity index (S) =

Where n = total number of species

Data were analysed using Microsoft Excel and PAST (version 3) software.

Results and Discussion

The results of this study showed that both *Cedrela odorata* and *Pinus caribaea* plantations are rich in understory species, 71 and 43 species respectively were identified. This high floristic richness could be attributed partly to strong contributions coming from the natural forests around, the heterogeneous distribution pattern in species composition and might be due to favourable climatic condition, which influenced the distribution of species. (Sebashao *et al.*, 2008; Addo-Fordjour *et al.*, 2009; Oladoye *et al.*, 2013, 2014,). High Density/ha in *Cedrela odorata* (192,750/ha), and *Pinus caribaea* (136,000/ha) (Table 1) could be a reflection of wider range ecological adaptation and activities of dispersal agents. *Caesalpinia pulcherima* had the highest IVI of (26.08), followed by *Chromolena odorata* (21.83) in *Cedrela odorata*, however, *Erangrostis tremula* had the highest IVI (27.02) followed by *Baphia nitida* (12.93) in *Pinus caribaea* These high IVI was a reflection of high frequency of individuals and high number (density) (Table 1). Species dominance was higher in *Pinus caribaea* (0.05) but species diversity was higher in *Cedrela odorata*. (Table 2). This is evident when only few species dominate the population. Species that dominate the pine plantation include *Ananas comosos, Baphia nitida, Chromolena odorata, Discorea bulbifera, Erangrostis tremula*. Species common to the two plantations are *Abrus precatorius, Albizia zygia, Baphia nitida, Canthium subcordatum, Carpolobia alba, Chromolena odorata, Cnestis ferugia, Combretum platypterum,* This study shows that despite the variation in the composition of the two

overstory plantations, similarities exist between the understory of communities of the two stands suggesting resilience of the occupying species to adapt and survive in any potential conditions. The abundance of species of *Leguminosae, Euphorbiaceae, Poaceae, Apocynaceae* may indicate that seedlings/saplings of these families contributed greatly to the composition of the understory in the forest floor. The presence of abundance of some species like *Cedrela odorata, Chromolena odorata, Discorea bulbifera, Baphia nitida* in nearly all the plots and their high density in the entire study area may indicate their wider range of ecological adaptation. *Cedrela odorata* plantation was typically richer in species composition than the *Pinus caribaea* plantation, this is evident in their number of species present and density/ha of the total species in each of the site (71 species; 192,750/ha) and (43 species; 136,000/ha) respectively. However, Pinus has slightly higher dominance (0.045) against 0.031 in Cedrela. In addition, the species were equally distributed under the two plantations (Table 2). High species richness recorded in the two plantations might be a display of heterogeneous nature in species composition, a function of the influence of climatic factors on species composition and distribution. In addition, it could also be a reflection of the rich soil nutrient status and composition of soil seed bank. (Ahmed *et al*, 2006; Oladoye *et al*., 2013 and 2014; Ahmad *et al*., 2020.)
The similarity of understory species composition between the *Cedrela odorata* and *Pinus caribaea* plantations was 0.53 (53%), indicating that about 53% of the understory species between the plantations are similar (Table 3). This suggests that about 47% of species between the two areas are completely different. The differences in species composition on the two study sites could be attributed to the interactive effects of several environmental factors and the nature of crown and extent of litter accumulation differ in the plantation stand (Asare *et al,* 2020). This result is consistent with the findings of Boakye (2012) who reported a higher composition of native plant species under Taungya plantations compared with natural and unmanaged plantation in Ghana, and Zhu and Zheng (2014) who reported species composition under open canopy plantation to be 2 to 3 times higher than plantations with a closed canopy.
In conclusion, this study has shown high species richness of understory, higher number of woody component (tree and shrub) under the two plantations may indicate the uniqueness and potentials of vegetation under these plantations for conservation of ecosystem and may act as catalyst for successful natural forest succession.

Table 1: Form, Density and Importance Value Index and Checklist of Species in *Pinus caribaea* and *Cedrela odorata* Plantations

-	-	-	*Pinus caribea*		*Cedrela odorata*	
Species	Form	Families	Density/Ha	IVI	Density/Ha	IVI
Raulvolfia vomitoria	Shrub	*Apocynaceae*	-	-	1750	3.7
Abrus precatorius	Shrub	*Leguminosae*	4000	5.94	875	1.37
Abutilon mauritianum	Shrub	*Malvaceae*	125	0.6	500	1.17
Adenai cissampeloides	Herb	*Passifloraceae*	-	-	750	0.88
Albizia zygia	Tree	*Leguminosae*	625	1.5	1000	1.43
Alframomum sceptrum	Herb	*Zingiberaceae*	-	-	125	0.56
Alstonia boonei	Tree	*Apocynaceae*	-	-	500	1.65
Amaranthus viridis	Herb	*Amaranthaceae*	-	-	125	0.75
Ananas comosus	Herb	*Bromeliaceae*	7125	12.74	-	-
Anthocleista liebrechtsiana	Shrub	*Loganiaceae*	-	-	1000	1.01
Aspilia Africana	Herb	*Compositae*	250	0.7	-	-
Baissea axillaris	Shrub	*Apocynaceae*	6000	8.41	-	-
Baphia nitida	Tree	*Papilionaceae*	8750	12.93	4625	4.69
Baphia nitida	Tree	*Papilionaceae*	-	-	1875	1.89
Baphia pubescens	Tree	*Papilionaceae*	-	-	125	0.56
Bombax brevicuspe	Tree	*Bombaceae*	-	-	125	0.56
Bombax buonopozense	Tree	*Bombaceae*	-	-	875	2.29
Bridelia micrantha	Tree	*Euphorbiaceae*	-	-	2500	3.13
Bryocarpus coccineus	Shrub	*Connaraceae*	-	-	39625	26.08
Cajanus cajan	Shrub	*Leguminosae*	125	0.6	-	-
Canthium glabriflorum	Tree	*Rubiaceae*	-	-	375	1.11

Canthium subcordatum	Tree	*Rubiaceae*	125	0.6	500	1.65
Carpolobia alba	Shrub	*Polygalaceae*	1375	3.01	125	0.56
Cassia podocarpa	Tree	*Polygalaceae*	2125	4.6	-	-
Cedrela odorata	Tree	*Meliaceae*	-	-	19125	15.92
Celtis zenkeri	Tree	*Ulmaceae*	-	-	250	1.04
Centrosema pubescens	Herb	*Papilionaceae*	-	-	875	1.85
Chenopodium ambrosioides	Herb	*Chenopodiaceae*	-	-	375	0.69
Chromolena odorata	Shrub	*Compositae*	23125	26	25125	21.83
Cleistopholia paterns	Tree	*Annonaceae*	-	-	125	0.56
Cnestis ferruginea	Shrub	*Connaraceae*	750	1.6	1625	2.68
Cocos nucifera	Tree	*Palmae*	-	-	125	0.56
Colocasia esculenta	Herb	*Araceae*	-	-	375	1.11
Combretum platypterum	Shrub	*Combretaceae*	125	0.6	375	1.59
Costus afer	Herb	*Zingiberaceae*	-	-	750	0.88
Croton lobatus	Herb	*Euphorbiaceae*	-	-	125	0.56
Cucurbita pepo	Herb	*Cucurbitaceae*	125	0.6	-	-
Culcasia scandens	Herb	*Araceae*	-	-	1125	1.5
Cylicodiscus gabunensis	Tree	*Leguminosae*	-	-	125	1.47
Cylodon dactylon	Grass	*Poaceae*	-	-	1125	2.42
Cymbopogon giganteus	Grass	*Poaceae*	-	-	3125	2.12
Cynometra megalophylla	Tree	*Leguminosae*	-	-	625	0.82
Cynometra vogelii	Tree	*Leguminosae*	-	-	500	0.75
Detarium senegalense	Tree	*Caesalpiniaceae*	750	1.6	-	-
Dichapetalum toxicarium	Shrub	*Dichapetalaceae*	3625	6.7	-	-

Dichapetalum toxicarium	Shrub	*Dichapetalaceae*	-	-	6625	8.04
Dicsorea bulbifera	Herb	*Discoreaceae*	7750	13.7	-	-
Dioscorea cayanensis	Herb	*Discoreaceae*	5500	8.54	1000	1.44
Discorea bulbifera	Herb	*Discoreaceae*	-	-	6375	7.91
Drynaria laurentii	Herb	*Polypodiaceae*	-	-	875	1.37
Drypetes leonensis	Tree	*Euphorbiaceae*	-	-	1000	1.02
Ehretia cymosa	Shrub	*Boraginaceae*	-	-	500	0.75
Elaeis guineensis	Tree	*Palmae*	2750	7.52	125	1.47
Elaeis guineensis	Tree	*Palmae*	-	-	-	-
Entada gigas	Herb	*Leguminosae*	250	0.7	875	1.37
Erangrostis tremula	Grass	*Poaceae*	30625	27.02	-	-
Erangrostis tremula	Grass	*Poaceae*	-	-	30500	19.05
Ficus capensis	Shrub	*Moraceae*	-	-	125	1.47
Ficus exasperata	Shrub	*Moraceae*	125	0.6	500	1.65
Funtumia elastica	Tree	*Apocynaceae*	250	1.2	-	-
Gmelina aborea	Tree	*Verbenaceae*	250	0.7	-	-
Gmelina aborea	Tree	*Verbenaceae*	-	-	375	1.59
Gongronema latifolium	Herb	*Asclepiadaceae*	-	-	125	1.47
Grewia mollis	Shrub	*Malvaceae*	-	-	2625	2.76
Guarea cedrata	Tree	*Meliaceae*	-	-	250	0.63
Hannoa klaineana	Shrub	*Simaroubaceae*	2250	4.7	-	-
Hedranthera barteri	Shrub	*Apocynaceae*	-	-	1000	1.02
Heliotropium indicum	Herb	*Boraginaceae*	-	-	5125	3.15
Hevea brasiliensis	Tree	*Boraginaceae*	3250	8.4	1750	4.14
Icacina tricantha	Herb	*Icacinaceae*	2000	4	-	-
Irvingia grandifolia	Tree	*Irvingiaceae*	-	-	250	0.63

Isolana campanulata	Tree	*Anacardiaceae*	500	0.9	-	-
Leonotis nepetifolia	Herb	*Labiatae*	500	0.9	-	-
Londetia phragmitoides	Grass	*Poaceae*	750	1.6	-	-
Macaranga barteri	Tree	*Euphorbiaceae*	-	-	1000	1.02
Maranthochloa congensis	Shrub	*Maranthaceae*	2750	4.02	5375	5.58
Massularia acuminate	Shrub	*Rubiaceae*	-	-	125	0.56
Melia azedarach	Tree	*Meliaceae*	1625	3.7	-	-
Microdesmis puberula	Shrub	*Euphorbiaceae*	1875	2.4	-	-
Milletia thonningii	Tree	*Leguminosae*	-	-	375	0.69
Morinda lucida	Tree	*Rubiaceae*	1125	1.83	-	-
Mukia maderaspatana	Herb	*Cucurbitaceae*	-	-	5750	8.51
Panicum maximus	Grass	*Poaceae*	-	-	250	1.04
Parkia clappertoniana	Tree	*Leguminosae*	-	-	375	0.69
Pausinystalia spp	Tree	*Rubiaceae*	2250	2.2	625	2.16
Piper guinense	Herb	*Piperaceae*	1000	1.24	-	-
Pseudarthria fagofolia	Shrub	*Fabaceae*	-	-	1125	3.38
Pycnanthus angolensis	Tree	*Myristicaceae*	1250	1.92	125	0.56
Rauvolfia vomitoria	Shrub	*Apocynaceae*	2750	5.02	-	-
Rhaphiostylis beninensis	Shrub	*Icacinaceae*	1750	3.8	-	-
Scottellia coriaceae	Tree	*Flacourtiaceae*	-	-	375	0.69
Setaria longiseta	Grass	*Poaceae*	-	-	2500	2.69
Smilax kraussiana	Shrub	*Smilacaceae*	500	0.9	-	-

Solenostemom monostachyus	Herb	*Lamiaceae*	-	-	500	0.75
Sphenocentrum jollyanum	Shrub	*Menispermaceae*	2375	3.8	-	-
Sphenocentrum jollyanum	Shrub	*Menispermaceae*	-	-	875	1.85
Tectona grandis	Tree	*Verbenaceae*	-	-	125	0.59
Triplochiton scleroxylon	Tree	*Sterculiaceae*	875	1.7	-	-
Total			136000		192750	

Table 2: Diversity of Species between *Cedrela odorata* and *Pinus caribaea* Plantations

	Cedrela odorata	*Pinus caribea*
No of species	71	43
No of individuals	1080	1000
No of families	37	30
Dominance_D	0.03189	0.04575
Simpson_1-D	0.9681	0.9543
Evenness_e^H/S	0.6446	0.6589
Equitability_J	0.897	0.8891

Table 3: Similarity of Species between *Cedrela Odorata* and *Pinus Caribaea* Plantations.

	Cedrela	*Pine*
Cedrela	1	
Pine	0.53488	1

References

Addo-Fordjour, P., Obeng, S., Anningand, A. K. and Addo, M. G. (2009). Floristic composition, structure and natural regeneration in a moist semi-deciduous forest following anthropogenic disturbances and plant invasion. *International Journal of Biodiversity* and *Conservation. 1(2), 021-037.*

Ahmad, N., Ashraf, M. I, Malik, S. U., Qadir, I., Malik, N. A and Khan K. (2020). Impact of climatic and topographic factors on distribution of sub-tropical and moist temperate forests in Pakistan, *Géomorphologie: relief, processus, environnement*, 26 (3), 157-172.

Ahmed, M., Husain, T., Sheikh, A. H., Hussain, S. S., Siddiqui, M. F. (2006). - Phytosociology and structure of Himalayan forests from different climatic zones of Pakistan. *Pakistan Journal of Botany*, 38(2), 361-383.

Asare, A., Asante, W. A., Owusu-Prempeh N., Opuni Frimpong E., and D. Adusu.(2020). Comparative Analysis of Understory Floristic Diversity and Carbon Stocks in Poorly and Intensively Managed Tectona grandis Plantations

International Journal of Forestry Research Volume 2020, Article ID 8868824, 13 pages https://doi.org/10.1155/2020/8868824

Badejo, M. A. and Ola-Adams, B. A. 2000. Abundance and diversity of Soilmites of fragmented habitats in a biosphere reserve in Southern Nigeria. Pesq. Agropec. Bras. Brasilia 35 (11): 2121-2128.

Boakye E. A., van Gils H., Osei Jr E. M.., and V. N. A. Asare, (2012). "Does forest restoration using taungya foster tree species diversity? The case of Afram Headwaters Forest Reserve in Ghana," *African Journal of Ecology*, vol. 50, no. 3, pp. 319–325, 2012.

Carnus J, Parrotta MJ, Brockerhoff EG, Arbez M, Jactel H, Kremer A, Lamb D, O'Hara K, Walters B. 2003. Planted forests and biodiversity. Paper Presented at: UNFF Intersessional experts Meeting on the Role of Planted Forests in Sustainable Forest Management; 2003 Mar 24–2003 Mar 30; New Zealand

Christian, D. P., Hoffman, W., Hanowski, J. M., Niemi, G. J. and Beyea, J. 1998. Bird and Mammal diversity on woody biomass plantations in North America. *Biomass and Bioenergy*, 14:395-402.

George, L. O. and Bazzaz, F. A. 1999. The fern understory as an ecological filter: growth and survival of canopy-tree seedlings. *Ecology* 80 (3), 846-856.

Gilliam, F. S. and Turrill, N. L. 1993. Herbaceous Layer Cover and Biomass in a young versus a mature stand of a central Appalachian hardwood forest. Bulletin of the Torrey Botanical Club, 445-450.

Karimu, S. A. 1999. The role of surrounding Communities on the management of Omo Forest Reserve. Consultant Report for FORMECU, Federal Department of Forestry, Abuja, Nigeria, 47pp.

Kimmins, J. P. 1987. *Forest Ecology*. Macmillian, London. 531pp. ISBN 0-02-364050-2

Lugo, A. E. 1997. The apparent paradox of reestablishing species richness on degraded lands with tree monocultures. *Forest ecology and management.* Vol. 99, Issues 1-2, pp. 9-19.

Ola-Adams, B. A. 1999. Biodiversity inventory of Omo Biosphere Reserve, Nigeria. Country Report on Biosphere Reserves for Biodiversity Conservation and Sustainable Development in Anglophone Africa (BRAAF) Project, 351pp.

Oladoye A.O, Adedeji O.H., Osinowo O.O, Basiru A.O. and Yisau J.A. (2013): Phytosociological Assessment of Understorey Species in *Leuceana Leucocephala* and *Gmelina Arborea* Stands in Federal University of Agriculture, Abeokuta, Nigeria. *Forests and Forest Products Journal*, 6:9-17. Published by the Forest and Forest products Society. www.fta-forest.org

Oladoye A.O, Aduradola A.M, Adedire M.O and Agboola D.A. (2014a). Composition and Stand Structure of a Regenerating Tropical Rainforest Ecosystem in South-western Nigeria. *International Journal of Biodiversity and Conservation, 6(11) 765-776. http://www.academicjournals.org/IJBC*

Oladoye A.O, Olubode O.S., Odeyale O.O and Ola J.A. (2014b): Structure and Composition of Woody Species in Riparian Forest in the University of Agriculture, Abeokuta, Nigeria. *Biological and Environmental Science Journal for the Tropics.*11 (3), 333-344. Published by Faculty of Science, Bayero University. Kano, Nigeria

Oladoye, A.O; Bello, O.S.; Basiru A.O.; Ige, P.O and Ezenwenyi J.U (2018). Above Ground Biomass and Carbon Stock of *Nauclea Diderrichii* (De Wild. & T. Durand) Merill Plantation in Omo Forest Reserve, Nigeria. *Journal of Forestry Research and Management. 15(2): 95-111.* Published by Forestry Research Institute of Nigeria. www.jfrm.org.ng

Otsoma, R. 2000. Integration of indigenous tree species into fast-growing forest plantations on imperata grasslands in Indonesia. Silvicultural solutions and their ecology and practical implications. Tropical Forestry Reports 2000; 21. University of Helsinki, Finland.

Parrotta, J., 1995. Influences of overstorey composition on overstorey colonization by native species on a degraded tropical site. *j. veg sci* 6, 627-636.

Ratsirarson, H., Robertson, H. G., Picker, M. D. and Noort, S. 2002. Indigenous forests versus exotic Eucalyptus and Pine plantations: a comparison of leaf-litter invertebrate communities. *African Entomology*, 10:93-99.

Sebastião, V. M; Elizabeth, R. B.; Ary, T. O; Alexandre, F. S; Elias, S. (2008). Floristic composition of two wetland forests in Araguaian Plain, State of Tocantins, Brazil, and comparison with other areas *Rev. Árvore*vol.32 no.1 Viçosa 2008.

Setiadi, D.,m Qoyim, I. and Muhandiono, H. 2001. *Guidance for Practical Ecology*. Ecology Laboratory. Department of Biology. FMNS, Bogor Agricultural University, Bogor. Indonesia.

Soerianegara I. and Indrawan A. 1998. Ekologi Hutan Indonesia.Laboratorium Ekology Hutan, Fakultas Kehutanan, Institute pertanian Bogor, Indonesia, pp. 1-104.

Tremblay, N. O. and Larocque, G. R. 2001. Seasonal dynamics of understory Vegetation in four Eastern Canadian forest types. *International Journal of Plant Sciences* 162 (2), 271-286.

Viisteensaari J, Johansson S, Kaarakka V, Luukkanen O. 2000. Is the alien species Maesopsiseminiia (Rhamnacae a threat to tropical forest conservation in East Usambaras, Tanzania.). *Environmental Conservation* 2000; 27:76-81.

Yirdaw, E. 2001. Diversity of naturally regenerated native woody species in forest plantations in the Ethiopian highlands. *New Forests*, 22: 159-177.

Yirdaw E. Restoration of the native woody species diversity using plantation species as foster trees in the degraded highlands of Ethiopia. PhD thesis. Helsinki: University of Helsinki; 2002.

Zhu, D. L and Zhang W. (2014). Effects of gaps on regeneration of woody plants: a meta-analysis. Journal of Forestry Re- search, vol. 25, no. 3, pp. 501–510, 2014.

39 ASSESSMENT OF MATING PROFILE OF RED SOKOTO BUCKS ADMINISTERED VARYING DOSAGE OF ETHANOLIC EXTRACT OF TIGER NUT (cyperus esculentus)

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Abstract
Tiger nut (Cyperus esculentus) is consumed by humans and livestock. It also has many medicinal uses such as aphrodisiac properties. There is an incidence of sexual incompetence, erectile dysfunction, premature ejaculation and reduced libido on the rise. . Hence, this study seeks to asses or evaluates the effect of ethanolic extract of tiger nut on mating traits or profiles of red Sokoto bucks. Consequently, the effect of ethanolic extract of tiger nut on mating profiles to determine the sexual performance efficiency in male Red Sokoto bucks were investigated. Nine (9) healthy red Sokoto bucks were divided in to three treatments of three bucks per treatment in a complete randomized design. The bucks were treated with ethanolic extract of tiger nut (EETN) at 0ml, 5ml and 10ml respectively for a period of 90 days (12wks). After which the bucks were allowed to mate with the does for the observation of sexual traits by introducing number of equivalents does (n=18). The mating parameters either decreased or increased in a EETN dose dependent manner; without traces of weaknesses or reduced penile reflexes and a higher significance function (p<0.05) was observed in group C. In conclusion EETN has a strong lasting potential on mating profile in male goats (buck) can be used as a fertility booster

KEY WORDS: *Cyperus* esculentus, Bucks, Aphrodisiac, libido, Erectile dysfunction.

Introduction

Herbal therapy remains a very vital aspect in the day-to-day treatment or management of sexual disorder and as such plants with aphrodisiac properties are being utilized in the management of this sexual scourge and to improve sex lives in traditional folklore (Prakash *et al*., 2015). Male sexual behavior consists of a complex pattern of genital responses, which when initiated, is maintained, and directed by signals and within and outside the body (Abedi *et al.,* 2014). The complex patterns include mating and premating behavour that allows the male to trace and mate, and asses her potential mating choice thereby stimulating a receptive reaction (Abedi *e* t *al.*, 2014). Mating abnormality is characterized by a range of sexual problems, which pose a serious health challenge being that a significant number of men are affected with the estimated value cutting across the globe (Prakash *et al*., 2015). Problems of sexual dysfunction and poor libido are on increase due to environmental pollution, lifestyle and nature of works Anderson (2018). In a mature buck, response to sexuality begins with a very hot sexual desire to erection, sniffing, bleating, then to orgasm and ejaculation (Prakash *et al.*, 2015). Thus, the ability to formulate a safe herbal therapy to combat this rising menace, which usually causes erectile dysfunction, will help in alleviating the plight of the victims. Tiger nut have been used over time to treat different ailments relating to infertility, low sperm count and poor libido in man and animals (Prakash *et al*., 2015, Adama *et al*., 2020). Thus, we attempt to research on something that can be used faster and with less financial implications compared to the orthodox medicine. Mating profile differs across species ranges from lower animals to the very large mammals. Series of parameters are investigated in the build–up to assessing mating behavioural changes in animals and man. Mount latency, mount frequency, intromission frequency, ejaculatory latency, post-ejaculatory interval, ejaculation frequency , intromission latency , inter –intromission interval and sometimes intromission ration have been reported (Obiandu *et al*., 2018). *Cyperus esculentus*, have been reported to stimulate male and female sexual performances. Cyperus esculentus (family Cyperecae) known as(“aya” in Hausa; “efa” Nupe;” “ofio” in Yoruba and Tiger nut in English and is cultivated in the hot and dry climatic regions of Africa as a potentials food sources(Sharma *et al*., 2010).

Materials and Method

The study was carried out at National Agricultural Extension Research and liaison Services, North central Zonal office, Baddegi, Niger state from April to June 2021. The state falls within the northern guinea savanna zone of Nigeria and is about 430m above the sea level. It is located between latitude 9^0 31' and 9^0 42’ North and longitudes 6^0 29’ and 6^0 41' East of equator. Niger state has two distinct climates, the dry season from (November to March). And the rainy season from (April – October) with mean annual rain fall between 1,000mm to 1,500 mm, with an average highest temperature in the month of March and lowest temperature in the month of August. The mean annual temperature is between, 21 to 36.5^0c. The relative humidity observed in the state varied from 15-65% - 26.39% (NASDP, 2020).

Collection of plant materials: Fresh tiger nut (*Cyperus esculentus*) were purchased from Kure Ultra –modern market, Minna, Niger state, Nigeria. The fresh tiger nut were screened and washed to remove sand and debris , sun dried and pulverized in to fine powder using pestle and mortar in line with (Ekalou *et al*.,2015). The tiger nut powder was soaked in 85% ethanol solution for 48 hours, mixed every 6 hours and then filtered using the muslin cloth. The filtrate was evaporated using rotatory evaporator. This was also to remove excess alcohol from the extract before finally kept in refrigerator for use throughout the experiment.

Source and Management of Experimental Animals:

Nine (9) red Sokoto bucks within the age range of 5-6 months were used for this study. The does were purchased from within Niger state principallyfrom goat market at Izom. The goats were allowed to acclimatize for a period of two (2) weeks.. During acclimatization, the goats were administered with Ivomectin®; a broad spectrum anti-parasitic drug, to remove both ecto and endo parasites. Broad spectrum anti-biotic (20 % Oxyteracycline manufactured by Heibei huarun pharmacy co Ltd, china), Penstrep (manufactured by Kepro, Holland), and some other drugs were administered when necessary to keep the animals in good health. Feed and water were provided ad libitum.

Experimental Design and Procedure

The nine (9) bucks were randomly divided in to four treatments in a completely randomized design. The animals were allowed to acclimatize for the period of two weeks before the commencement of the research. The bucks in control and treatment groups were treated with 0ml, 5ml and 10ml of tiger nut extract per kilogram body weight thrice (3) in a week respectively through oral gavage throughout the experiment. .After 4week (30 days) of experiment , mount latency, mount frequency , intromission frequency, ejaculatory latency , post –ejaculatory interval, ejaculation frequency , intromission latency, inter-intromission interval were keenly observed after introducing (does). Adienbo *et al*., (2013) method for determining sexual characteristics in animals were adopted for mating profile in this present study.

Data analysis.

Data collected were subjected to the analysis of Variance (ANOVA) Using SAS statistical package (SAS, 2006). Duncan Multiple Range Test was employed to separate the treatment means.

Results

Results of Mating Profile of Red Sokoto Bucks Administered Varying Dosage of Ethanolic Extract

of Tiger Nut (*cyperus esculentus*) is here presented in Table 1. Administration of ethanolic extract of tiger nut (EETN) for a periods of 90days had a significant effects ($p<0.05$) in ML, IL, PEI, EL, EF, MF and III compared to the control

TABLE 1: Mating profiles in bucks administered varying dosage of ethanolic extract of tiger nut for 90 days

PROFILE	CONTROL	5mg	10mg	SEM
Mount latency (ML) sec.	183.16 ± 0.2^{c}	406.15 ± 0.2^{b}	791.27 ± 0.3^{a}	0.34
Mount frequency (MF)	2.32 ± 0.9^{c}	3.71 ± 0.3^{b}	5.89 ± 0.3^{a}	0.23
Intromission latency (IL) sec.	114.55 ± 4.1^{a}	224.80 ± 2.7^{b}	322.23 ± 1.1^{a}	0.25
Intromission frequency (IF)	11.06 ± 0.5^{c}	31.93 ± 0.6^{b}	42.02 ± 0.4^{a}	0.26
Ejaculation latency (EL) sec.	345.37 ±	434.90 ±	541.22 ± 2.1^{a}	0.42
Ejaculatory frequency (EF)	3.1^{bc}	3.7^{ab}	3.05 ± 0.9^{a}	0.31
Post – ejaculatory interval (PEI)	1.75 ± 0.4^{c}	2.75 ± 0.4^{b}	485.12 ± 1.3^{a}	1.23
sec.	295.62 ± 2.3^{c}	385.50 ±	54.11 ± 2.2^{a}	0.32
Inter – intromission interval (III)	34.58 ± 0.2^{bc}	1.1^{ab}	4.05 ± 0.1^{a}	0.27
sec.	2.70 ± 0.3^{c}	43.19 ± 0.6^{ab}		
Intromission ratio (I/R)		3.79 ± 0.5^{b}		

abc means within a row having with different superscripts differed significantly ($p<0.05$).

Discussion

In this study, we defined each parameter for a mating profile to enable the understanding of the terms that constitutes sexual traits in bucks (Atoigwe *et al*. 2015). The mount latency (ML) is the interval from the introduction of does to the first mount. Mount frequency (MF) showed the number of mounts prior to an ejaculation while inter-intromission interval (III) is the average intromission between succeeding intromissions. These observations were significantly demonstrated by the ethanolic extract of tiger nut especially on the 30 day of administration as compared to the control (1-3). This proofs that ethanolic extract of tiger nut has aphrodisiacs potentials (Ekaluo, *et al*., 2015), which emphasized the need for reduced time of ML, IL, PEI, and III as an indication of power, potency , improved sex drive and vigour in sexuality. These findings support the claim in which reduced ML, IL, PEI, and III were observed to be a reflection of sexual inspiration in animals (Fourche *et al*., 2015).

This also support the findings of Atoigwe *et al*., (2015) who opined that Garcina kola seed caused a highly significant($p< 0.01$) increase in MF, EL, IF, and IR and that a rise indicates that Garcina kola is capable of causing improved sexuality in treated bucks.. This finding is further buttressed by the report of Fouche *et al*. (2015) who stated that MF is an important measure of both libido and potency and as such an elevated value is indicative of a sustained increase in sexual stimulus or activities and aphrodisiac property in a plant. While there is an affirmation that elevated MF is believed to be an important index of sexual stimulus ,efficacy of erection and coordination(Prakash *et al* ., 2015) while intromission frequency (IF) observed as the number of vaginal penetration until there is a discharge, which differs from intromission latency (IL) that relates to the recorded time from when a does is introduced in to the investigation pen to the first vaginal penetration (Atoigwe *et al* .,2019).

A delayed penetration is an indication of poor sexual performance, viability and reduced libido. This findings revealed a dosages dependent in intromission frequency (IF) from the ethanolic extract and a reduction in IL in a similar manner as reported by Atoigwe *et al* ., (2015). This research agrees with an earlier report by Atoigwe *et al*., (2015) who opined that medicinal crops with possible potentials to improve sexual arousal, sexual stimulus ought to result in a significant increase in IF and decrease IL, which are both indicative of aphrodisiac activities. This agrees with Sharma et al., (2010) who reported that a significant rise in the sum of intromission frequency (IF) is an indication of erectile efficiencies ,penile positioning and the perfect manner at which ejaculatory reflexes are coordinated after activation. The improvement observed in sex drive, sexual ability, vigour, strength and erectile viability was further corroborated by increase intromission ration (I/R) across all the treatment groups compared to control. This supported the findings of Allouh *et al*., (2015) who defined the intromission ration as the extent of successful vaginal penetration, which is calculated as intromission frequency (IF)/ (mount frequency +intromission frequency). However, the degree of efficiency or improvement is best shown in treatment two (2) and three (3) as compared to treatment 1(control).

The intensity of sexual libido increases along line of doses which agrees with Adama *et al*., (2020) who lamented that this increasement in sexual urge appetite was as a result of administered extract. Other parameters like ejaculatory frequency (EF), which is the number of discharges observed from the period of mount to a specified time frame (40 minutes). Ejaculatory latency (EL) being the time between the first intromission and the first discharge. Post ejaculatory interval (PEI) as the time between a discharge following the vaginal penetration. Anderson (2011) argued that the ability to engage in the act of sexual performance depend on the erectile function thus it can be observed that erectile dysfunction, affect the entire sex life even when there is a very strong sexual urge. The above research reveals adequate penile erection and penetration was more pronounced in bucks in treatment two and three but significantly higher ($p<0.05$) in treatment three which agrees with Adama *et al*. (2020); in which erection was observed in all the treated rabbits (2020) in a doses dependent manners.

Conclusion

In conclusion, this study shows that ethanolic extract of tiger nut (EETN) has a potential for the reactivation of sexual dysfunction in a dosage dependent manners. EETN can be used as a fertility booster and in attenuating sperm

References

Adama, J.Y., Idris , F. M and A. Usman (2020). Reproductive Performance of Rabbits administered graded doses of tiger nut (Cyperus esculentus)extracts. *Nigerian Journal of Agriculture and Forestry*, 7(1), 82-88

Abedi A, karimian SM, Parvez M, Muhammad P and Roudsari HRS (2014). Effects of aqueos extract of *Phoenix dactylifera* pollen on dopamine system of nucleus accumbens in male rats. *Neuroscience* and *Medicine* 5(3) 49-59.

Adienbo OM, Nwafor A and Ronami SO (2013). Effects of Hydromethanolic extract of Xylopia aethopica on sexual behavior jn male Wistar rats. *International Journal of Advanced Biological Research*, 1(9):1078-1085.

Allouh MZ, Daradka HM and Abu-Ghaida JH (2015). Influence of Cyperus esculentus Tubers (Tiger nut) on male rat copulatory behavior. *BMC complementary and Alternative Medicine*, doi:10.1186/s12906-015-0851-9.

Anderson KE (2011). Mechanism of penile erection and basis for pharmacological treatment of erectile dysfunction. *Pharmacology Review*, 63(4):811-859.

Atoigwe –Ogeyemhe BE, Odigie EB, and Chukwu PU (20918).Aqueos extract of Cyperus esculentus L (Cypereceae) enhances libido and spermatogenesis in male Wistar rats . *Tropical Journal of Natural Product Research* , 2(11):471-475.

Ekaluo , U.B, Ikpeme, E.V., Ibiang , Y.B and Amacchina, O.S.(2013). Attenuating role of Vitamin on Sperm toxicity induced by caffeine in albino rats. *Journal of Medical Science*, 13:3-7

Fouche G, Afolayan AJ, Mintola OA, Khorombi TE and Senabe J (2015). Effect of the aqueous extract of the aerial parts of Mansonia angustifolia E. Mey. EX A. Rich , on the sexual behavior of male Wistar rats. *BMC complementary and Alternative Medicine*,15:343-353.

Prakash R, Dheeraj R, Muralidharan P, Karchikeyan K, Viljayarkumar R, and Prabu TP, (2015). Aphrodisiac activity of cocos nucifera 67.attenuates ceric sulphate induced infertility in male rats. *PTB Reports* , 1(2):62

Sharma V, Thakur M, Chauhan NS and Dixit VK, (2010). Effects of petroleum ether extract of Anacyclus pyrethrum DC on sexual behavior of male rats. *Journal of Chinese integrated medicine*, 8(1):767-773.

40 APPARENT NUTRIENT DIGESTIBILITY AND PERFORMANCE OF GROWER PIGS FED ENERGY AGRO BY-PRODUCTS

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ABSTRACT

A six-week feeding trial was conducted to determine the visible nutrient digestibility and performance of grower pigs fed energy agro by-products. The dietary energy agro by-products used were; maize as control, palm kernel meal (PKM), brewer's dried grain (BDG) and wheat offal (WO) at 44% levels of replacement respectively. Thirty-two (32) cross bred grower pigs (Large white x Landrace) were randomly allocated to four (4) treatments diets (1,2, 3 and 4) in a complete randomized design (CRD). Each treatment group contained four grower pigs of two (2) males and females grower pigs replicate twice making a total of eight pigs per treatment. Feed and water were supplied as ad libitum. Nutrient digestibility was significantly ($p<0.05$) affected, while performance characteristics such as weekly weight gain and average weight gain per pig were also significantly ($P<0.05$) influenced by the treatments with pkm (5kg) having highest mean value compared to 4.4kg, 4.1kg and 4.4kg for treatments 1, 3 and 4 respectively. Feed intake (FI) and feed conversion ratio were not significantly ($P>0.05$) influenced by dietary treatments, with mean values ranged between 24.4kg in the brewer's dried grain diet to 30.2kg in palm kernel meal diet. In conclusion, the results above revealed that the experimental animals fed palm kernel meal treatment diet comparatively perform better than other dietary treatments is therefore recommended as an agro energy by-product in grower pigs diet.

Key words: Grower pigs digestibility performance feed

INTRODUCTION

Livestock production constitutes an important component of the agricultural economy in developing countries and it is an instrument of socio-economic change, increase income and improve quality of rural life (Igene *et al*., 2013). Igene (2022) noted that among the multiple role of livestock industry, food production and gainful employment are the most important. He further observed that in over 12 million in West Africa, of whom over 2 million are in Nigeria, depend on livestock and livestock related enterprises for their livelihood. The role of monogastric food animals; swine and poultry in particular, has increased animal potential in Sub-Sahara Africa cannot be overemphasized (Amaefule *et al.,* 2009). Philip (2012) observed that animal proteins from pig and poultry have become major source of protein and are consumed by over 70%

globally. The growth and development of the industry has tremendously evolved from backyard business to commercially based industry (Igene and Oboh, 2006). Globally, the piggery and poultry industry are characterized by relative faster growth in consumption and trade volume than many other agricultural livestock subsectors (Esonu *et al.*, 2001). In African countries to be precise Nigeria, nutrition is one of the major bottlenecks to the survival and satisfactory productivity of man. Igene (2022) stated that nutrition supply for any type of external and internal use which involves the ingestion, digestion, transportation, absorption and assimilation of various nutrients and their movements to all body cells and removal of unusable materials and waste products of metabolism. To address the problems associated with feeding and compilation, the use of conventional feed must be de-emphasized (Kim *et al.*, 2011). One of the ways of tackling this issue is by adopting the use of agro by-products in feeding approaches. Very many agricultural by-products exist around the globe particularly in Nigeria which can be well harnessed in pig feeding (production). The focus of this research is utilization of these non-conventional agro by-products of brewer's dried grain (BDG), palm kernel meal (PKM), and wheat offal (WO) as alternative to conventional maize in grower pigs' diets.

MATERIALS AND METHODS

Experimental Site, Ingredients and Duration

The experiment was conducted at the Piggery Unit of the Teaching and Research Farm of the Faculty of Agriculture, Ambrose Alli University, Ekpoma in Esan West Local Government Area of Edo State, Nigeria. The farm is located in the tropical savanna rainforest vegetation belt, with Longitude 6.44^{o}C North and 6.08^{o}C East with mean ambient temperature of about 29^{o}C and relative humidity of about 76%. All the feed (experimental) ingredients were purchased at Animal Feed Shops in Benin City, Edo State. The experiment lasted for a period of six weeks.

Management of Experimental Animals and Design

Thirty-two (32) grower pigs crossbred Large white, and Landrace mixed with (males and females), an average weight of 20.8kg were used for the experiment. They were divided into four (4) groups based on their average initial weight, were allocated to four treatment diets (1,2,3 and 4), each treatment group had eight (8) grower pigs of two (2) males and females replicated four (4) in a complete randomized design (CRD). Sanitary hygienic conditions were kept throughout the experimental period and the grower pigs were allowed for five days acclimatization period before the commencement of the feeding trial. Animals were fed twice daily (morning and evening) while water was supplied as required throughout the experimental period. Routine vaccination, medication and other management practices were observed.

Diet Formulation

The experimental diets were formulated with maize (control), were palm kernel meal (PKM), brewer's dried grain (BDG) and wheat offal (WO) replaced maize. Diet 1, served as the control contained maize while diets 2, 3 and 4 had palm kernel meal, brewer's dried grain and wheat offal to replace maize at 44% across the treatments as source of energy on weight equalization basis as shown in Table 1.

Data Collection and Analysis

The initial weights of the experimental animals (grower pigs) were taken at the beginning of the experiment and subsequently at weekly intervals throughout the duration of the feeding trial.

Parameters that were assessed included initial weight (kg), average weekly feed intake (kg), average weekly weight gain (kg) and feed conversion ratio. Data were subjected to a one-way analysis of variance (ANOVA) and means were compared using Duncan's Multiple Range Test (1955) as described by Steel and Torrie (1990).

Table 1: Composition of experimental diets

Ingredients %	Diet 1 Maize	Diet 2 PKM	Diet 3 BDG	Diet 4 WO
Maize (control)	44.0	0	0	0
Palm Kernel Meal (PKM)	0	44.0	0	0
Brewer' Dried Grain (BDG)	0	0	44.0	0
Wheat Offal (WO)	0	0	0	44.0
Cassava	30.6	30.6	30.6	30.6
Groundnut Cake (GNC)	20.0	20.0	20.0	20.0
Blood Meal	3.5	3.5	3.5	3.5
Bone Meal	2.0	2.0	2.0	2.0
Vit/Min Premix	0.25	0.25	0.25	0.25
Lysine	0.15	0.15	0.15	0.15
Methionine	0.15	0.15	0.15	0.15
Salt	0.25	0.25	0.25	0.25
Total	100	100	100	100
Calculated:				
Crude Protein (%)	21.69	22.97	22.39	21.55
Energy (Kcal/kg)	3002.24	2852.24	2878.07	2789.59

Results and Discussion

Table 2: Performance of Grower Pigs Fed Agro By-Products

Parameters	Dietary Treatments				
	1	2	3	4	
	Maize (Control)	PKM	BDG	WO	SEM
Ave. initial weight (kg)	20.0	21.4	20.6	20.4	
Ave. final wt/pig (kg)	47.4[b]	51.6[a]	45.0[b]	47.2[b]	1.56
Ave. weekly feed intake (kg)	14.03	14.30	14.03	13.01	0.59
Ave. total wt gain/pig (kg)	26.6[ab]	30.0[a]	24.4[b]	26.8[ab]	0.75
Ave. weekly wt gain/pig (kg)	4.4[ab]	5.0[a]	4.1[b]	4.4[ab]	0.78
Ave. feeds conversion ratio (kg)	3.30	2.90	3.40	3.20	0.28
Mortality %	0.00	0.00	0.00	0.00	

abc: means in the same row with different superscripts are significantly ($P<0.05$) different.

The results shown on Table 2, revealed that the final weight gain was significantly ($P<0.05$) higher in palm kernel meal diet compared to other diets. This could be as a result of the presence of oil in the by-products which have enhanced the amount of calories in the PKM as supported by Olomu (1995) and De Lange (*et al*., 2010). The total weight gain was also highest in the PKM compared to the maize controlled diet. There were comparable values for average total weight of the experimental animals in treatments 1 and 4 while treatment 3 was least with a value of 24.4 kg. This result is agreement with the findings of Igene and Oboh (2006) and comparably to the findings of De La Liata *et al*. (2011). Indices on this result did not show any significant (P>0.05) difference on the feed conversion ratio though the value in diet 2 revealed that it is more technically advisable to adopt PKM.

Table 3: Nutrient Digestibility of Grower Pigs Fed Different Energy Based Agro By-Products

Parameters	Dietary Treatments				
	1	2	3	4	
	Maize (Control)	PKM	BDG	WO	SEM
Dry matter %	79.41^{cb}	81.01^{c}	82.11^{b}	83.41^{a}	0.31
Crude Protein %	80.43^{b}	88.61^{a}	74.34^{c}	81.00^{b}	1.21
Crude Fibre %	64.00^{bc}	74.41^{a}	63.44^{c}	65.01^{b}	1.43
Ether Extract %	82.51^{b}	83.33^{a}	82.00^{b}	82.84^{b}	1.31
Ash %	48.88^{b}	53.41^{a}	47.33^{b}	48.11^{b}	0.61
NFE %	89.14^{a}	85.46^{b}	81.34^{c}	88.91^{a}	1.43

abc: means in the same row with different superscripts are significantly (P<0.05) different.

There were significant (P<0.05) differences on the apparent nutrients digestibility trials. Dry matter digestibility was highest in wheat offal compared to the control. Crude protein digestibility was significantly (P<0.05) highest in PKM diet and was followed by comparable values of 81.00 and 80.43 % in treatments 4 and 1 respectively. Other digestible nutrients assayed showed significant (P<0.05) effects across the treatments diets. Ether extract, crude fibre and ash were revealed to be highest in dietary treatment 2 with PKM. The results of this research was supported by the findings of Igene and Oboh (2006) and Awojobi *et al*., (2011) but differ on the report of Olomu (1995) and Wenk (2001) who reported none significant (P>0.05) difference on dry matter ash digestibilities.

Conclusion

The results above revealed that palm kernel meal (PKM) could be used to wholly replace maize which has been in use conventionally as energy product in grower pig diet.

Recommendations

I. Small farm holders and millers should be encouraged and educated on the use of PKM.
II. PKM should be investigated as alternative to maize in the growth and digestibility performance of weaners, fatteners and breeder pigs.

References

Amaefule, K.U; Abasiekong, S.F; Ibe, S.N and Onwudike, O.C (2009). Digestibility and Nutrient Utilization in some Agro Industrial By-products Fed to Growing Pigs in the Humid Tropics. *Pakistan Journal of Nutrition, 8: 355-360.*

Awojobi, H.A; Okuboyejo, T.A and Akinrinmisi, O.O (2011).Response of Baby Pigs to Three Weaning Ages (4,6 and 8 weeks): Haematology and Didestibility. Proc. 36th Conference; Nigerian Society of Animal Production, 13-16 March, 2011, Universityu of Abuja, Nigeria.

DE La Liata, M; Svitz, S.S; Tokach, M.D; Goddband, R.D; Nelson, J.L and Loughin, T.M (2001). Effect of Dietary Fat on Growth Performance and Carcass Characteristics of Growing-Finishing Pigs Reared in a Commercial Environment. *Journal of Animal Science, 79; 2643-2650.*

De lange, C.FM; Pluske, J.R; Gong, J and Nyachoti, C.M (2010). Strategic use of Feed Ingredients and Feed Additives to Stimulate Gut Health and Development in Young Pigs. *Livestock Science, 134: 124-134.*

Esonu, B.O; Udedibie, A.B.I; Emenadom, O.O; Herbert, U; Epor, C.F; Okoli, I.C and Iheukurumene, F.C (2001). Performance and Blood Chemistry of Weaner Pigs Fed Raw Mucuna Beans (Velvet beans) Meal. *Tropical Animal Production Investigation.*

Igene, F.U (2022). Monogastric for Sustainable Food Security, Improved Health condition and Poverty Alleviation. Inaugural Lecture, Abrose Alli University, Ekpoma, Nigeria; Thursday 27th Jan. 2022. Pp.2.

Igene, F.U; Abieyuwa, O and Okoruwa, M.O (2013). Bread and Biscuit Wastes as Alternative Dietary Energy Sources in Broiler Chicken Diets. *Tropentag, September 17-19, 2013, Stuttgart- Hohenhein, Germany.*

Igene, F. U and Oboh S.O (2006).Utilization and Biochemical Assessment of Rubber Seed Cake in Broiler Diet. *Nigerian Journal of Agriculture and Forestry, 1 (2): 24-30.*

Kim, J.C; Mullan, B.P; Nichollas, R and Pluske, J.R (2011). Effects of Australian Sweet Lupin (*Lupinus augustifolius*) Inclusion Levels and Enzyme Supplementation on the Performance and Meat Quality of Grower Pigs. *Animal Production Science, 51: 37-43.*

Olomu, J.M (1995). Monogastric Animal Nutrition; Principles and Practice. Jachem Publication, Benin City, 1st Edition, Pp: 130-150.

Philip, A. Thacker (2012). Effect of Wheat Distiler's Grains with Soluble and a Feed Flavour on Performance and Carcass Traits of Growing-Finishing Pigs fed Wheat and Canola Meal Based Diets. *Archives of Animal Nutrition, 1-14.*

Steel, R.G.D and Torrie, J.H (1990). Principles and Proceedures of Statistics. A biochemical approach. (3rd ed. Mc Craw Hill Book Co. New York, USA.

Wenk, C (2001). The Role of Dietary Fibre in the Digestive Physiology of Pig. *Animal Feed Science and Technology, 90: 21-23.*

41 FREE RADICAL SCAVENGING ACTIVITY OF SELIM POD (Xylopia aethiopica)

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ABSTRACT
This study was carried out to determine the antioxidant activity of the selim pod (Xylopia aethiopica). Extracts of Xylopia aethiopica pods were investigated for their free radical scavenging activities in the presence of 2, 2-diphenyl-1-picrylhydrazyl (DPPH), using ascorbic acid as the standard antioxidant. The result revealed that with an increase in the concentrations of the selim pod extract from 0.2 to 1.0 mg/ml, the free radical scavenging activity of the selim pod extracts also increased from 16.04 to 48.17%. The DPPH free radical scavenging activity of the selim pod is observed to be dose-dependent. The antioxidant activity of the extract of Xylopia aethiopica was examined and the results were compared to that of ascorbic acid which served as the standard. The percentage inhibition of ascorbic acid (vitamin C) at the concentration of 1mg/ml was 97.05% meanwhile that of selim pod at the same concentration, the inhibition recorded was 48.17%. Although the free radical scavenging activity is lower than that of ascorbic acid, notwithstanding, the result suggests that Xylopia aethiopica has potential antioxidant properties which could be exploited as a natural antioxidant for use in animal nutrition and the food industry.

KEYWORDS: Scavenging activity; *Xylopia aethiopica*; phytochemicals; antioxidants

INTRODUCTION

Selim pod *(Xylopia aethiopica)* is a medicinal plant growing in various parts of Africa (Yin *et al.*, 2019) It is sometimes referred to as Negro pepper and Guinea pepper, and is one of the most valuable spices with numerous health benefits (Yin *et al*., 2019). *Xylopia aethiopica* is a spice that is used in flavouring local dishes and the pods are sold as condiments. It is a medicinal plant that has been utilized traditionally in the treatment of several diseases and ailments (Yin *et al*., 2019).

Xylopia aethiopica is a rich source of phytochemicals and possesses free radical scavenging abilities, it could, therefore, be utilized in the management of free radical-related degenerative diseases by exploiting them as natural antioxidants in food systems (Okechukwu-Ezike and Oly-Alawuba, 2020). John-Dewole *et al*. (2012) from their in vitro studies with the extracts of selim, reported that it exhibited some anti-microbial and pharmacological properties which might be due to the presence of phytochemicals in the plant.

According to Melo *et al*. (2021), *Xylopia aethiopica* contains phenolics and essential oils which might be linked with the remarkable antioxidant, antimicrobial, and moderate anti-SARS-CoV-1 and SAR-CoV-2 activities. *Xylopia aethiopica* has been reported to have antimicrobial and free radical scavenging activity and this could be associated with the presence of polyphenols in the plant (Apenteng *et al*., 2016). Literature is scarce on the antioxidant potential of Nigerian *Xylopia aethiopica* to the best of the authors' knowledge.
This research study was therefore conducted to evaluate the antioxidant activity of selim pod (*Xylopia aethiopica*) to determine its potential for possible application in animal nutrition.

MATERIAL AND METHODS

Sample extract preparation

Accurately 1g of the grounded selim pod was weighed into a conical flask. Then 100ml of ethanol was then added to the weighed samples. The samples were extracted using a digital 4 holes water bath (Model: E-Track England) at 70 degrees for 40 minutes, then later cooled at room temperature and transferred into a 100ml volumetric flask. The samples were filtered using a Whatman filter paper No. 1.

Assay of DPPH Free Radical Scavenging Activity

The DPPH radical scavenging activity of the selim pod extracts was examined in line with the procedure described by Mukherjee *et al*. (2011) with slight modifications. The concentration of 100 μM of DPPH was dissolved in methanol to a final concentration of 0.03mM. Serial dilutions were made to check the IC50. The values of IC50 signify the concentration of the sample, which is required to scavenge 50% of DPPH free radicals. The IC50 values were calculated by linear regression of plots. The contents were mixed and incubated for 30 minutes at 37°C. To determine the absorbance at 517 nm, a UV spectrophotometer was used. Vitamin C (ascorbic acid) was used as the standard control antioxidant. All readings were taken in triplicate and the mean values were then recorded. The decrease in absorbance indicated increased radical scavenging activity. The percentage inhibition of the samples at the different doses was calculated using the formula;

$$\% \text{ Inhibition} = \frac{Ao - As}{Ao} \times 100$$

Where Ao is the absorbance of the control and As is the absorbance of the test sample (selim pod)

RESULTS AND DISCUSSION

The results revealed that with an increase in the concentrations of the selim pod extract from 0.2 to 1.0 mg/ml, the free radical scavenging activity of *Xylopia aethiopica* extracts also increased from 16.04 to 48.17% (Figure 1)

The DPPH free radical scavenging activity of the selim pod is observed to be dose-dependent. The antioxidant activity of the extract of *Xylopia aethiopica* was examined and the results were compared to that of ascorbic acid which served as the standard. The percentage inhibition of ascorbic acid (vitamin C) the antioxidant used as standard, at the concentration of 1mg/ml was 97.05% meanwhile that of the selim pod at the same concentration the inhibition recorded was 48.17% (Figure 1).

The IC50 value recorded for *Xylopia aethiopica* was 0.94mg/ml against the IC50 value of 0.44mg/ml of ascorbic acid. However, contrary to the result obtained in this study for the IC50 for *Xylopia aethiopica*, Ngwoke *et al.* (2015) reported a lower value of 0.62.mg/ml for acetone extracted *Xylopia aethiopica* and a much lower value of 0.28mg/ml for aqueous extracted *Xylopia aethiopica*. This variation may be due to differences in the method of extraction used for the test sample while other likely factors contributing to the disparity in result may be; cultivar type, climatic and soil conditions, storage and handling, etc.

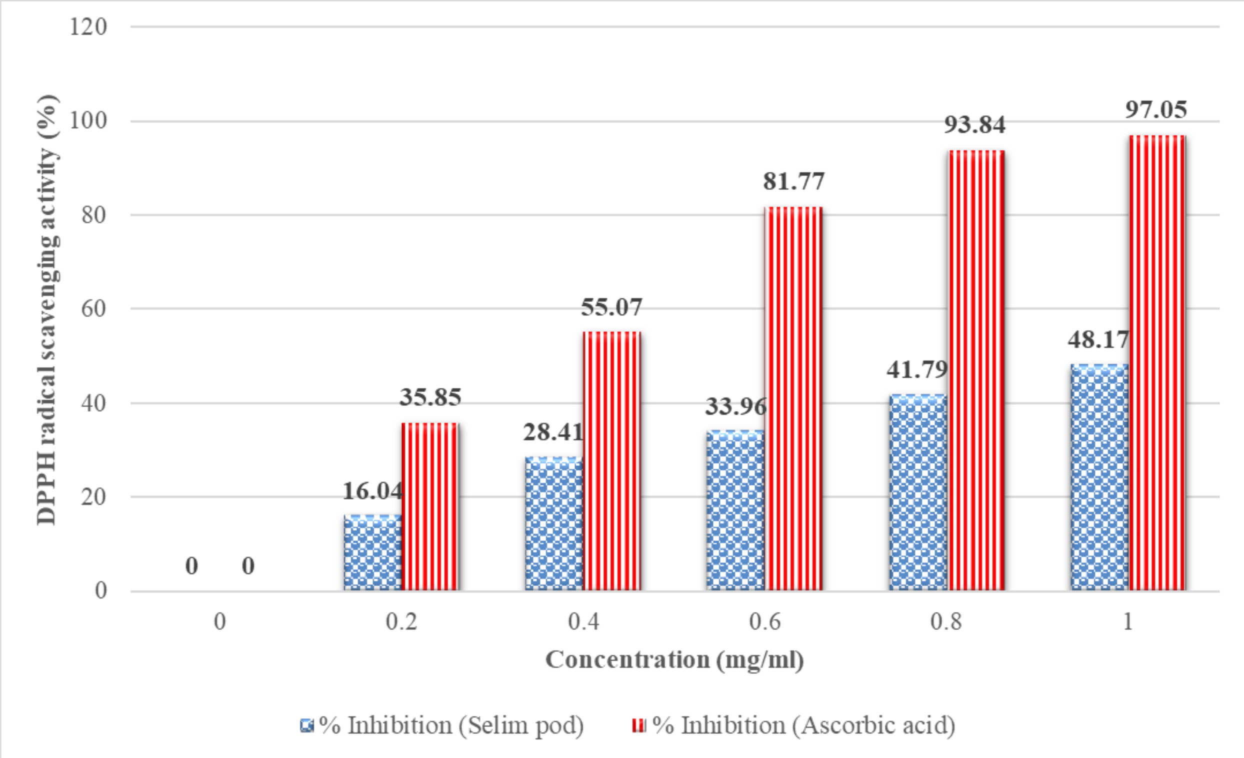

*Figure 4: Antioxidant activity of selim pod (*Xylopia aethiopica*)*

CONCLUSION

The findings of this study revealed that *Xylopia aethiopica* has antioxidant properties. Selim pod, therefore, has promising potential for use as an antioxidant agent in livestock feeds, food products, and the pharmaceutical industry.

REFERENCES

Apenteng, J. A., Ogundeyi, M., Oppong, E. E., Osei-Asare, C., & Brookman-Amissah, M. G. (2016). In vitro Anti-infective and Antioxidant activity of *Xylopia aethiopica* [Dun.] A. Rich: A comparison of the fruits and leaves extracts. *Journal of Medicinal Plants Studies*, 4, 24-29.

John-Dewole, O. O., Agunbiade, S. O., Alao, O. O., & Arojojoye, O. A. (2012). Phytochemical and antimicrobial studies of extract of the fruit of *Xylopia aethiopica* for medicinal importance. *Journal of Biotechnology and Pharmaceutical Research*, 3(6), 118-122.

Melo, C., Perdomo, R., Yerima, F., Mahoney, O., Cornejal, N., Alsaidi, S., Coron, S., Bonnaire, T., Zhang, S., Zydowsky, T.M., Priano, C., Fernández Romero, J.A., Rodolfo Juliani, H., & Koroch, A. (2021). Antioxidant, antibacterial, and anti-SARS-CoV Activity of commercial products of Xylopia (*Xylopia aethiopica*). *Journal of Medicinally Active Plants*, 10(1), 11-23.

Mukherjee, S., Pawar, N., Kulkarni, O., Nagarkar, B., Thopte, S., Bhujbal, A., & Pawar, P. (2011). Evaluation of free-radical quenching properties of standard Ayurvedic formulation Vayasthapana Rasayana. *BMC Complementary and Alternative Medicine*, 11,38.https://bmccomplementmedtherapies.biomedcentral.com/articles/10.1186/1472-6882-11-38

Ngwoke, K.G., Ikeanyi, A.U., Eze, P.M., Ezemokwe, I.C., Abba, C.C. and Ugwu, M.C. (2015). Phytochemical and Antioxidant Properties of Extracts of *Xylopia aethiopica* Fruits.

Chemical Science Review and Letters 4(13), 267-270.

Okechukwu-Ezike, N.C. and Oly-Alawuba, N. M. (2020). Assessment of the Phytochemical Contents and Antioxidant Activities of Some Herbs and Spices in South-Eastern Nigeria. *Research Journal of Food and Nutrition*, 4(3) pp. 1-5.

Yin, X., Chávez León, M.A.S.C., Osae, R., Linus, L.O., Qi, L.W., Alolga, R.N. (2019). *Xylopia aethiopica* Seeds from Two Countries in West Africa Exhibit Differences in Their Proteomes, Mineral Content and Bioactive Phytochemical Composition. *Molecules*, 23, 24(10):1979. DOI: 10.3390/molecules24101979. PMID: 31126018; PMCID: PMC6572195.

42 ASSESSMENT OF DIFFERENT DOSES OF AQUEOUS RED HOT PEPPER EXTRACT ON THE GROWTH PERFORMANCE OF THREE BREEDS OF BROILER CHICKENS

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Abstract

A four-week study was carried out to examine different doses of aqueous hot red pepper extract on the growth performance of three broiler breeds. A total of 216 Arbor acre, Ross 308 and Cobb 500-day old chicks were allotted into four treatments in a randomized complete block design using a 3 x 4 x 3 factorial arrangement. Treatment (T1) was the control without pepper extract; T2, T3, and T4 were the dosage level of 3, 3.5, and 4 mL, respectively. Parameters evaluated were mean final body weight, body weight gain, feed conversion ratio, daily feed intake, and daily weight gain. Results showed that they were all significantly (P< 0.05) affected. On the basis of breed effect, Cobb 500 performed better in the final weight gain, feed conversion ratio, final body weight, and daily weight gain when compared to Arbor acre and Ross 308. Based on level of inclusion, birds administered 3, and 3.5 mL were significantly (P>0.05) the same in terms of final body weight (1131.8g, 1165.3g); birds on 3 mL had the best feed conversion ratio (1.79) when compared to birds on the other dosage level. Breed x level interaction did not lead to any significant (P>0.05) effect on final body weight gain, total feed intake, final body weight, daily feed intake, and daily weight gain. It was concluded that, differing dosage of the aqueous extract improved productivity of the birds, which is related to the breed, and the level of inclusion.

Keywords: Hot red pepper dosage, aqueous extract, growth performance, breeds, and level.

Description of Problem

Poultry is one of the fastest growing segments of the agricultural sector in Nigeria today. In a bid to increase body weight gain, and feed efficiency, growth promoters are usually used as in-feed, or even in the water of birds. This growth promoters can be categorized as Antibiotic Growth Promoters (AGP) and Non–Antibiotic Growth Promoters (NAGP). AGPs in broiler chickens industry have been used to boost growth efficiency and feed conversion ratios (Miles *et al.*, 2006).

Red pepper is rich in vitamins C, E, and capsaicin (Lee *et al.*, 2010; Shahverdi *et al.*, 2013). Hot red peppers, also known as chili peppers, owe their “heat” to capsaicin (Al-Kassie *et al.*, 2011; Shahverdi *et al.*, 2013). Luqman and Razvi (2006) stated that capsicum was more active than vitamin E in inhibiting lipid peroxidation. Capsaicin can potentiate the activities of pancreatic and intestinal enzymes (Platel and Srinivasan, 2004), increase bile acid secretion (Abdel *et al.,* 2005), and increase body weight gain in broiler chickens (Puvača *et al.*, 2014, 2015). This active ingredient had been shown to have a defending purpose in the gastric mucosa as a stimulant of afferent nerve endings. Al-Kassie *et al.* (2012), explained that hot red pepper being rich in vitamin C, has a considerable impact in improving production through contributing to the reduction of heat stress.

Pepper has been used extensively as a growth promoter in broiler chickens production. It was used up to 2 mL in water by Abdulrasheed (2021) with great results in terms of final body weight but with a higher cost of producing I Kg of body weight gain. Reports on the evaluation of breed effect as it relates to the use of aqueous pepper extract is scarce. Hence, the aim of this study was to assess different dosage rates of aqueous red hot pepper extract on the growth performance of three breeds of broiler chickens

Materials and Methods

The study which lasted for 28 days was conducted at the poultry section of the Department of Animal Production teaching and research farm, School of Agriculture and Agricultural Technology, Federal University of Technology Minna, Gidan Kwano Campus. Three different breeds of broiler chicks (Arbor acre, Ross 308, and Cobb 500) were used for the study. In total, 216 day old chicks were used for the experiment. On arrival, water containing Vitalyte® was administer to the birds, followed by brooding which lasted for two weeks.

A complete basal diet consisting of maize, maize bran, palm oil, and 30% broilers starter concentrate was formulated to supply 22% CP and 2850 Kcal/Kg Metabolizable Energy (ME) to the birds. The hot red pepper used for the work was purchased from Minna modern market. This was transported to the laboratory where it was washed, followed by blending which was done at a 1:1 ratio (1 Kg of pepper: 1 litre of water). The extract was collected after filtration using a muslin sheet and stored in a refrigerator to prevent spoilage until when required for use. The aqueous extract was administered via drinking water on a daily basis at a dosage rate of 0, 3, 3.5, and 4 mL, respectively in 4 litres of water. The day old chicks were allotted into the treatment groups and the design involve the use of a 3 x 4 x 3 factorial arrangement in a randomized completely block design (3 breeds, 4 levels of inclusion, and 3 replication of 18 birds per treatment.

Routine management practices were observed in rearing the birds. Parameters measured were: mean final body weight, body weight gain, feed conversion ratio, daily feed intake, and daily weight gain. All data obtained were subjected to a two-way analysis of variance using the General Linear Model procedure of the Statistical Package for Social Sciences (SPSS). The statistical model used for the experiment was;

$Y_{ij} = \mu + \alpha_i + \beta_j + \alpha\beta_{ij} + e_{ijk}$

Where Y_{ij} is the observed response, μ is the overall mean, α_i is the main effect (breed), β_j is the effect of the dosage rate, $\alpha\beta_{ij}$ is the effect of interaction between the breed and dosage rate, and e_{ijk}

is the random error effect.

Results and Discussion

The main effect of treatment on the growth performance of three broilers breeds is presented in Table 1. The results revealed significant ($P<0.05$) main effect of treatment on final body weight, final body weight gain, daily body weight gain, and feed conversion ratio of the birds with Cobb 500 birds having the better performances (1258.60 g, 1222.60 g, 52.44 g, 1.66, respectively) compared to the Ross 308 and Arbor acre birds. The good performances observed for the birds following aqueous red hot pepper treatment is in agreement with previous findings (Al-Kassie *et al.*, 2011; Al-Kassie *et al.*, 2012; Shahverdi *et al.*, 2013); the authors reported that inclusion of hot red pepper in broiler chickens diet improved weight gain, feed intake and feed conversion ratio. No significant ($P>0.05$) main effect was observed for total and daily feed intake of the birds.

Based on dosage rate, significant ($P>0.05$) effect was observed for all the parameters evaluated, except for total and daily feed intake. Birds on 3 and 3.5 mL aqueous red hot pepper extract had better performances in final feed intake, total and daily body weight gain, while those on 3 mL had the best feed conversion ratio. El-Deek *et al.* (2012) observed that the body weight gain of broiler chicken was higher in birds whose diet was supplemented with hot red pepper at the level of 1.5 and 3 g/Kg of feed as compared to those on Oxytetracycline® and the control group. Wadasen (2012) observed the mean final weight gain of broiler chickens to be significantly higher in birds on diets supplemented with hot red pepper (0.5, 1.0, and 1.5 %) compared to the control group. The results of the current study seems to suggest a linear relationship between aqueous red hot pepper dosages with the performance indices as there's improvement with increasing dosages compared to the control. Only the feed conversion ratio show breed x dosage rate interaction which is critical as it helps farmers in deciding the best combination of breed (Cobb 500) and dosage rate (3 mL) to be used for better performance.

Conclusion

Inclusion of aqueous red hot pepper extract in drinking water influenced the performance of the broiler chickens with Cobb 500 being better. Dosage rate of 3 and 3.5 mL also led to better performances when compared to the control and are therefore, recommended to farmers.

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References

Abdel, O.M.E, Heikal, O.A. and El-Shenawy, S.M. (2005). Effect of capsaicin on bile secretion in the rat. *Pharmacology,* 73: 121-128.

Abdulrasheed, I. (2021). Growth performance of broiler chickens administered different levels of aqueous extract of red hot pepper. B.Agric.Tech. thesis. Department of Animal Production, Federal University of Technology, Minna, Niger State, Nigeria.

Al-Kassie, G.A.M., Mamdooh, A.M., Al-Nasraw, S. and Ajeena, S.J. (2011). Use of black pepper (*Piper nigrum*) as feed additive in broiler diet. *Research Opinions in Animal and Veterinary Science,* 1(3): 169-173.

Al-Kassie, G.A.M., Butris, G.Y. and Ajeena, S.J. (2012). The potency of feed supplemented mixture of hot red pepper and black pepper on the performance and some hematological blood traits in broiler diet. *International Journal of Advanced Biological Research,* 2: 53-57.

EL-Deek, A.A., Al-Harthi, M.A., Osman, M., AlJassas, F. and Nassar, R. (2012). Hot pepper (*Capsicum annum*) as an alternative to Oxytetracycline in broiler diets and effects on productive traits, meat quality, immunological responses and plasma lipids. Archiv Für Geflügelk, 76(2): 73-80.

Lee, S.H., Lillehoj, H.S., Jang, S.I.K., Kim, D.K., Ionescu, C. and Bravo, D. (2010). Effect of dietary *Curcuma, capsicum*, and *Lentinus* on enhancing local immunity against, *Eimeria acervulina* infection. *The Journal of Poultry Science,* 47: 89-95.

Luqman, S. and Razvi, S.I. (2006). Protection of lipid peroxidation and carbonyl formation in proteins by capsaicin in human erythrocytes subjected to oxidative stress. *Phototherapy Resource,* 20: 303-306.

Miles, R.D., Butcher, G.D., Henry, P.R. and Little, R.C. (2006). Effect of antibiotic growth promoters on broiler performance, intestinal growth parameters, and quantitative morphology. Poultry Science. 85(3): 476-485.

Platel, K. and Srinivasan, K. (2004). Digestive stimulant action of spices: a myth or reality? *The Indian Journal of Medical Research,* 119(5): 167-179.

Puvaca, N., Ljubojevic, D., Lukac, D., Kostadinovic, L.J., Stanacev, V., Popovic, S., Zivkov Balos, M. and Nikolova, N. (2014). Digestibility of fat in broiler chickens influenced by dietary addition of spice herbs. *Macedonian Journal of Animal Science,* 4: 61-67.

Puvača, N., Kostadinović, L.j., Ljubojević, D. and Lukac, D. (2015). Effect of dietary red hot pepper addition on productive performance and blood lipid profile of broiler chickens. First International Symposium of Veterinary Medicine. Pp: 183-187.

Shahverdi, A., Kheiri, F., Faghani, M., Rahimian, Y. and Rafiee, A. (2013). The effect of use of red pepper (*Capsicum annum*) and black pepper (*Piper nigrum* L) on the performance and hematological parameters of broiler chicks. *European Journal of Zoological Research,* 2: 44-48.

Wadasen, M.L.P. (2012). Study on the effect of hot red pepper (*Capsicum annum*) supplementation on the growth performance of broilers. M.Sc. Thesis, Benguet State University, La Trinidad Bengue.

Table 1: Growth performance of broiler chickens on different dosages of aqueous red hot pepper extract

	IBW	FBW	FBWG	DWG	TFI	DFI	FCR
Main effect							
Arbor acre	33.85±0.40	1064.45^{c}±32.14	1031.45^{c}± 0.97	44.35^{c}±1.24	2070.20±69.50	42.25±1.24	2.01^{c}±0.04
Ross 308	34.92±0.04	1086.38^{b}±32.14	1051.38^{b}±0.97	45.26^{b}±1.24	2086.00±69.85	42.46±1.24	1.98^{b}±0.04
Cobb 500	36.03±0.04	1258.60^{a}±32.14	1222.60^{a}±0.97	52.44^{a}±1.34	2026.50±69.85	45.46±1.24	1.66^{a}±0.04
LS	NS	*	*	*	NS	NS	*
Dosage rate (mL)							
0		1051.b^{4}±37.12	1016.57^{b}±36.91	43. 81^{b}±1.55	2220.70±69.85	45.31±1.43	2.23^{c}±0.04
3		1166.2^{a}±37.12	1131. 8^{a}±36.91	48.59^{a}±1.55	2020.2±69. 85	41.23±1.43	1.79^{a}±0.04
3.5		1200.4^{a}±37.12	1165.3^{a}±36.91	50.02^{a}±1.55	2004.1±69. 85	44.98±1.43	1.90^{b}±0.04
4		1127.7^{ab}±37.12	1092.9^{ab}±36.91	46.99^{ab}±1.55	2066.2±69. 85	42.20±1.43	1.91^{b}±0.04
LS		*	*	*	NS	NS	*
Main x dosage rate interaction		NS	NS	NS	NS	NS	*

^{abc}: means denoted by different superscripts are significantly different (P>0.05), IBW = initial body weight, FB = final body weight, FBWG = final body weight gain, DWG = daily weight gain, TFI = total feed intake, DFI = daily feed intake, FCR = feed conversion ratio, LS = level of significance, NS = not significant (P>0.05).

43 ANTIOXIDANT ACTIVITY OF SUN-DRIED TROPICAL LEMON (Citrus limon) PEEL

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ABSTRACT

The peels of lemon (Citrus limon) are the major by-products obtained during the processing of lemon and are most of the time discarded as food waste. Lemon peels have been reported to possess many bioactive substances with beneficial properties. These properties may probably have potential applications for use in agriculture, industry, aquaculture, medicine and food processing. This research was conducted to determine the antioxidant activity of lemon peels. The free radical used was 2, 2-diphenyl-1-picrylhydrazyl (DPPH), while ascorbic acid was used as the standard antioxidant for the analysis. The DPPH free radical scavenging activity of the lemon peel extracts increased from 6.29 to 53.32% with a corresponding increase in the concentrations of the peel extract from 0.2 to 1.0 mg/ml. The lemon peel extracts, therefore, exhibited DPPH free radical scavenging activity in a dose-dependent manner. The inhibition of ascorbic acid at the concentration of 1mg/ml was 98.65% while for the lemon peel at the same concentration the inhibition obtained was 53.32%. Lemon peels which are considered a waste product have been shown to possess some level of antioxidant activity. The half-maximal inhibitory concentration (IC50) is the value of the test sample that can scavenge 50% of DPPH free radical. The IC50 value recorded for the lemon peel was 0.93mg/ml as against the IC50 value of 0.41mg/ml of ascorbic acid. Lemon peels are by-products that may be used as a potential low-cost natural antioxidant source for human food and animal feed.

KEYWORDS: lemon peel; scavenging activity; antioxidant; free radical; sun-drying

INTRODUCTION

Lemon (*Citrus limon*) is a typical citrus fruit. The plant is a potent source of vitamin C. The peels of lemon (*Citrus limon*) are the main by-products obtained during the processing of lemon fruit and are most of the time discarded as food waste. Lemon peel forms around 40–50% of the total fruit mass which is mostly considered a waste (Singh *et al.*, 2020). The peel of a lemon is made up of two distinct layers, the outer layer is called the flavedo (epicarp) while the inner layer of the peel (the white spongy part) is called the albedo (mesocarp). Nevertheless, lemon peels have been reported to demonstrate several bioactivities that are beneficial (Liu *et al.*, 2022). Lemon peels also contain pectin and fibre and can be useful as prebiotics (Jiang *et al.*, 2022).

Plants with free radical scavenging properties and antioxidant capacity are valuable for pharmaceutical, agricultural, and industrial applications and as food and feed additives. Research authors have employed many methods in processing lemon peel like; oven drying freeze drying, air drying/shade drying and microwave drying.

To the best of the authors' knowledge, literature is scarce on research work done on the antioxidant potential of sun-dried lemon peels. In the tropics, the sun-drying method may be advantageous, low-cost and a better option for processing lemon peels.

This research work aimed to evaluate the antioxidant activity of sun-dried lemon peels and to identify their potential for possible use as a food and feed additive.

MATERIALS AND METHODS

Processing of Test Sample

The lemon fruits were hand peeled and the peels were collected and cut into small pieces and sun-dried for 3 days. They were then grounded and packed in airtight polythene bags. The ground samples of the peels were taken for laboratory analysis for the determination of antioxidant activity.

Preparation of Sample Extract

The sample extract was prepared by weighing 1g of the dried sample into a conical flask. Then 100ml of ethanol was added to the weighed sample. The extraction of the sample was carried out by using a digital 4 holes water bath (Model: E-Track England) at 70 degrees for 40 minutes. This was then cooled at room temperature and transferred into a 100ml volumetric flask. Extracts were filtered using a Whatman filter paper (No. 1).

Free Radical Scavenging Assay

To determine the antioxidant activity of the extract, 2, 2-diphenyl-1-picrylhydrazyl (DPPH) was used as a free radical according to the method outlined by Mukherjee *et al.* (2011) with minor modifications. The concentration of 100 μM of DPPH was dissolved in methanol to a final concentration of 0.03mM. Serial dilutions were made to check the IC50. In 96-well microplate total volume was 100 μl which was consisting of 90 μl of DPPH solution and 10 μl of the test solution. Different concentrations (0.2, 0.4, 0.6, 0.8 and 1.0 mg/ml) of the extracts and ascorbic acid (the standard antioxidant) were used. The contents were mixed and incubated for 30 minutes at 37°C. To determine the absorbance at 517 nm, an ultraviolet (UV) spectrophotometer was used. The decrease in absorbance indicated increased radical scavenging activity which was determined by the following formula for DPPH:

$$\text{DPPH Scavenging activity (\%)} = \frac{\text{AC} - \text{AS}}{\text{AC}} \times 100$$

AC= Absorbance of control

AS = Absorbance of sample

RESULTS AND DISCUSSION

In this study, the DPPH free radical scavenging activity of the lemon peel extracts ranged from 6.29 to 53.32%. The antioxidant activity increased with the increasing concentrations of the peel extract from 0.2 to 1.0 mg/ml (Figure 1). The lemon peel extracts showed DPPH free radical scavenging activity in a dose-dependent manner.

The inhibition of ascorbic acid (the standard antioxidant used) at the concentration of 1mg/ml was 98.65% while for the lemon peel at the same concentration, the inhibition obtained was 53.32% (Figure 1). Abd El-ghfar *et al*. (2016) reported 52.64% free radical scavenging activity for dried lemon peel this value is close to the value obtained in this study.

In contrast to the value recorded in this study, Olyad *et al.* (2020) reported a much higher value of approximately 68% at the same concentration (1mg/ml). The differences in these results may be due to variations in cultivar, processing method and environmental factors. Other possible factors that may be responsible for variability in results generally are as follows; 1) different test models or assays used. 2) The composition of the lemon peel analysed, may be affected by the way the lemon is peeled, whether it was hand-peeled or knife peeled. This would affect the proportion of epicarp and mesocarp in the test sample. 3) Whether the lemon was ripe or not ripe before peeling. 4) The method of drying used. 5) The handling and storage conditions. 6) Growing conditions and soil fertility.

The IC50 which is the half-maximal inhibitory concentration that is the value of the test sample that can scavenge 50% of DPPH free radical. The value of IC50 is inversely proportional to the antioxidant activity of the sample that is, the lower the IC50 value the higher the scavenging activity.

The IC50 value recorded for the lemon peel was 0.93mg/ml against the IC50 value of 0.41mg/ml of ascorbic acid. These values are the concentration required to attain a 50% radical-scavenging effect.

According to Abd El-ghfar *et al.* (2016), the presence of natural flavonoids, phenolics, ascorbic acid and carotenoids is responsible for the antioxidant activity of lemon peels. As a result of the level of antioxidant activity exhibited by lemon peels, is it recommended for consideration as potential natural additives in food products and feeds to enhance the antioxidant activity and improve shelf-life.

Pieracci *et al.* (2022) in their experiment obtained 0.70mg/ml as the IC50 of lemon pulp waste while that of orange pulp waste was 0.81mg/ml. These values are lower than the values obtained for lemon peels in this study, probably because it was a pulp waste and not a peel waste, as there might be some difference in their composition although both are considered by-products of citrus fruits.

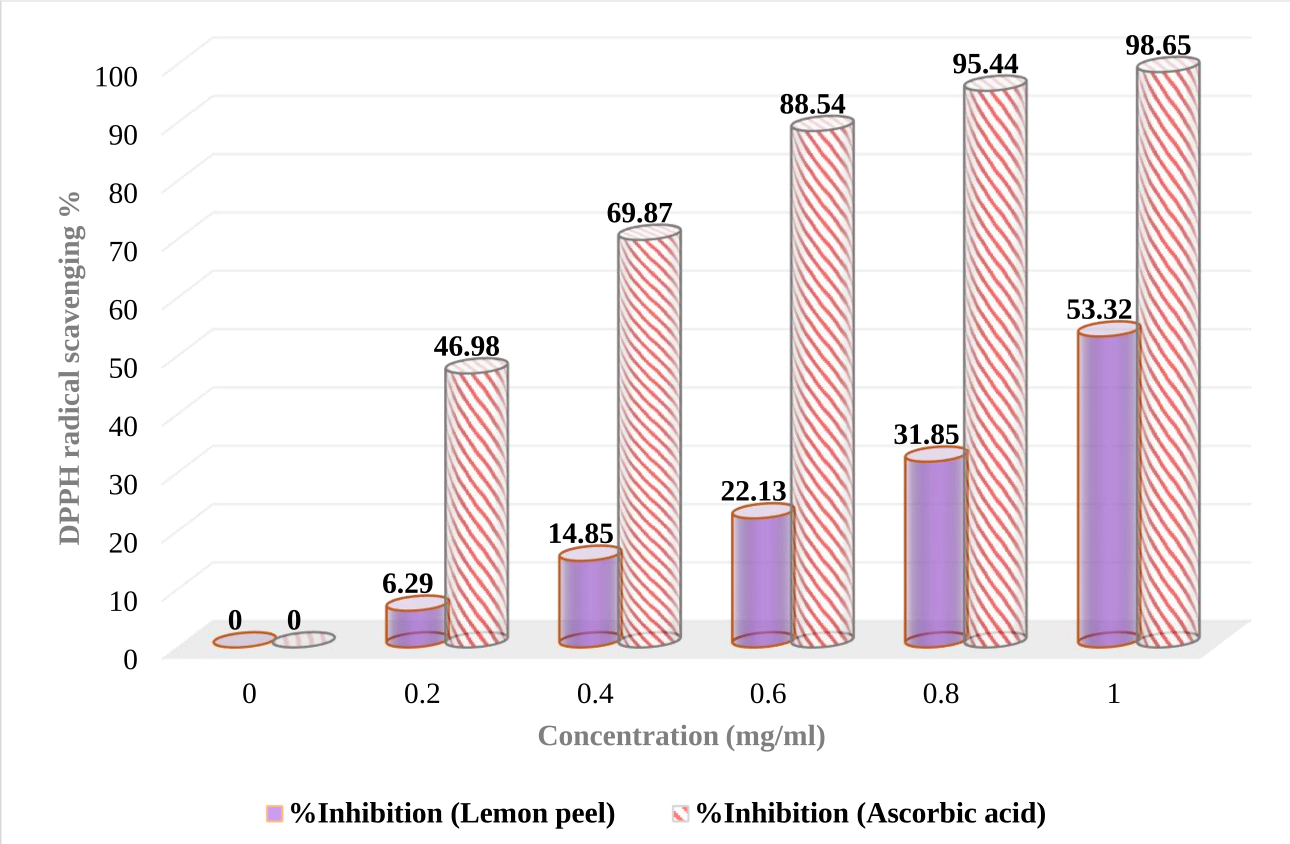

Figure 5: Free radical scavenging activity of sun-dried lemon peel

CONCLUSION

The sun-dried lemon peels used in this experiment are a cheap source of natural bioactive compounds with good antioxidant activities. This citrus by-product is not only cheap but considered safe and with health-promoting benefits, capable of protecting the cell against free radical damage. Also, the peels are natural by-products that can act as a good source of antioxidant for possible application in foods, drugs and feeds and may replace synthetic antioxidant derivatives.

REFERENCES

Abd El-ghfar, M. A., Ibrahim, H. M., Hassan, I. M., Abdel Fattah, A. A., & Mahmoud, M. H. (2016). Peels of lemon and orange as value-added ingredients: chemical and antioxidant properties. *International Journal of Current Microbiology and Applied Sciences*, 5, 777-794.

Jiang, H., Zhang, W., Xu, Y., Chen, L., Cao, J., & Jiang, W. (2022). An advance on nutritional profile, phytochemical profile, nutraceutical properties, and potential industrial applications of lemon peels: A comprehensive review. *Trends in Food Science & Technology*. 124, 219-236. https://www.sciencedirect.com/science/article/pii/S0924224422001492.

Liu, N., Yang, W., Li, X., Zhao, P., Liu, Y., Guo, L., Huang, L., & Gao, W. (2022). Comparison of characterization and antioxidant activity of different citrus peel pectins. *Food Chemistry*, 386,132683. https://www.sciencedirect.com/science/article/pii/S0308814622006458

Mukherjee, S., Pawar, N., Kulkarni, O., Nagarkar, B., Thopte, S., Bhujbal, A., & Pawar, P. (2011). Evaluation of free-radical quenching properties of standard Ayurvedic formulation Vayasthapana Rasayana. *BMC Complementary and Alternative Medicine*, 11, 38. https://bmccomplementmedtherapies.biomedcentral.com/articles/10.1186/1472-6882-11-38

Olyad, E. R. B. A., Atomsa, D., Chimdessa, M., & Gonfa, T. (2020). Determination of flavonoid contents and evaluation of in vitro antioxidant activities of the extract of selected citrus fruit peel. *International Journal of Secondary Metabolite*, 7(1), 8-18.

Pieracci, Y., Pistelli, L., Cecchi, M., Pistelli, L., & De Leo, M. (2022). Phytochemical Characterization of Citrus-Based Products Supporting Their Antioxidant Effect and Sensory Quality. *Foods*, 11(11), 1550.

Singh, B., Singh, J. P., Kaur, A., & Singh, N. (2020). Phenolic composition, antioxidant potential and health benefits of citrus peel. *Food Research International*, 132, 109-114.

44 EVALUATION OF Syzygium *aromaticum* (CLOVE BUD) AS A POTENTIAL SOURCE OF NATURAL ANTIOXIDANT

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ABSTRACT
Cloves are a group of aromatic plants that are used widely due to their positive effects on the growth and health of poultry, probably as a result of their immune-stimulatory properties. Clove (Syzygium aromaticum) has attracted attention due to its potent antioxidant activities standing out among other spices. The present study was carried out to determine the antioxidant activity of clove bud using ascorbic acid as standard and 2, 2-diphenyl-1-picrylhydrazyl (DPPH) as free radical. The DPPH inhibition activity was carried out using the standard method. The DPPH inhibition activity of the clove extract was observed to increase from 18.17% to 65.12% with increasing concentration of the clove extract from 0.2 to 1.0 mg/ml. The clove bud extract was observed to have DPPH inhibition activity and exhibited a dose-dependent trend. The IC50 value for the clove and ascorbic acid were 0.725 and 0.320 respectively. Clove bud has the potential to serve as a natural substitute for synthetic antioxidant feed additives.
KEYWORDS: *Syzygium aromaticum*; natural antioxidant; feed additive; free radicals

INTRODUCTION

Spices are mostly used for seasoning and flavouring in food preparation. Clove is an ancient spice, that is obtained from the scented dried flower bud from the clove tree. It is an invaluable multipurpose spice that possesses a strong spicy aroma (Hussain *et al*., 2017). The major bioactive volatile compound in clove bud is eugenol, this may one of the active substances in clove bud responsible for its antioxidant activity (Kamatou *et al.*, 2012; Gaspar *et al.*, 2018).

Clove bud is a good source of phenolic compounds such as eugenol, eugenol acetate, and gallic acid. The presence of these substances has been linked with their antimicrobial and antioxidant property (Cortés-Rojas *et al*., 2014).

There is a rising need for the replacement of synthetic antioxidants with natural sources that are easily available and safe. Therefore, the present research work was carried out to evaluate the antioxidant potential of the clove bud and the possibility of its inclusion as a natural food and feed additive.

MATERIALS AND METHODS

Source of Experimental Test Material

Clove bud (*Syzygium aromaticum*) was purchased from Kure ultra-modern market Minna, Niger state. The clove bud was sun-dried for three days and was thereafter ground to powder and stored in plastic containers.

Plant Extract Preparation

The extract preparation of the dried clove bud was carried out by weighing one gramme (1g) of the grounded sample into a conical flask. Afterwards, 100ml of ethanol was measured and then added to the weighed sample in the flask. Extraction was performed for 40 minutes with the use of a digital 4 holes water bath (Model: E-Track England) at 70 degrees. The resultant extract was allowed to cool at room temperature and then filtered using a Whatman filter paper (No. 1).

DPPH (2,2-Diphenyl-1-Picrylhydrazyl) Radical Scavenging Assay

In this experiment, the free radical used to evaluate the antioxidant activity of clove bud was 2, 2-diphenyl-1-picrylhydrazyl (DPPH), in line with the procedure described by Mukherjee *et al*. (2011) with slight changes. 2, 2-diphenyl-1-picrylhydrazyl of 100 μM concentration was dissolved in methanol to a final concentration of 0.03mM. Serial dilutions were made to determine the IC50. In 96-well microplate total volume was 100 μl which was consisting of 90 μl of DPPH solution and 10 μl of the test solution. The contents were mixed and incubated for 30 minutes at 37°C. An ultraviolet spectrophotometer was used to determine the absorbance at 517 nm. Ascorbic acid was used as the standard antioxidant. All readings were taken in triplicate and the mean values were then recorded. A decrease in absorbance indicated increased radical scavenging activity which was determined by the following formula:

$$\%\ \text{Inhibition} = \frac{A_c - A_t}{A_c} \times 100$$

A_c = Absorbance of control

A_t = Absorbance of the test sample

RESULTS AND DISCUSSION

The DPPH free radical scavenging activity of clove bud in the present study ranged from 19.65% to 67.23%. The inhibition activity of the clove bud against free radicals increased with increasing levels of its extract concentration from 0.2mg/ml to 1.0mg/ml. Implying that the inhibition activity of the clove bud was directly proportional to the level of its extract concentration. The anti-free radical activity was expressed as IC50 (mg/ml), which is defined as the extract concentration necessary to scavenge 50% DPPH free radicals (Selles *et al.*, 2020). The IC50 value of 0.725mg/ml was obtained for the clove bud extract, whereas that of ascorbic acid was 0.320mg/ml. These values are the concentrations needed to achieve a radical scavenging outcome of 50 per cent. The inhibition of DPPH was 67.23% at the concentration of 1.0mg/ml of clove bud extract, this value falls within the range reported by Ahmed (2016), although at a lower concentration.

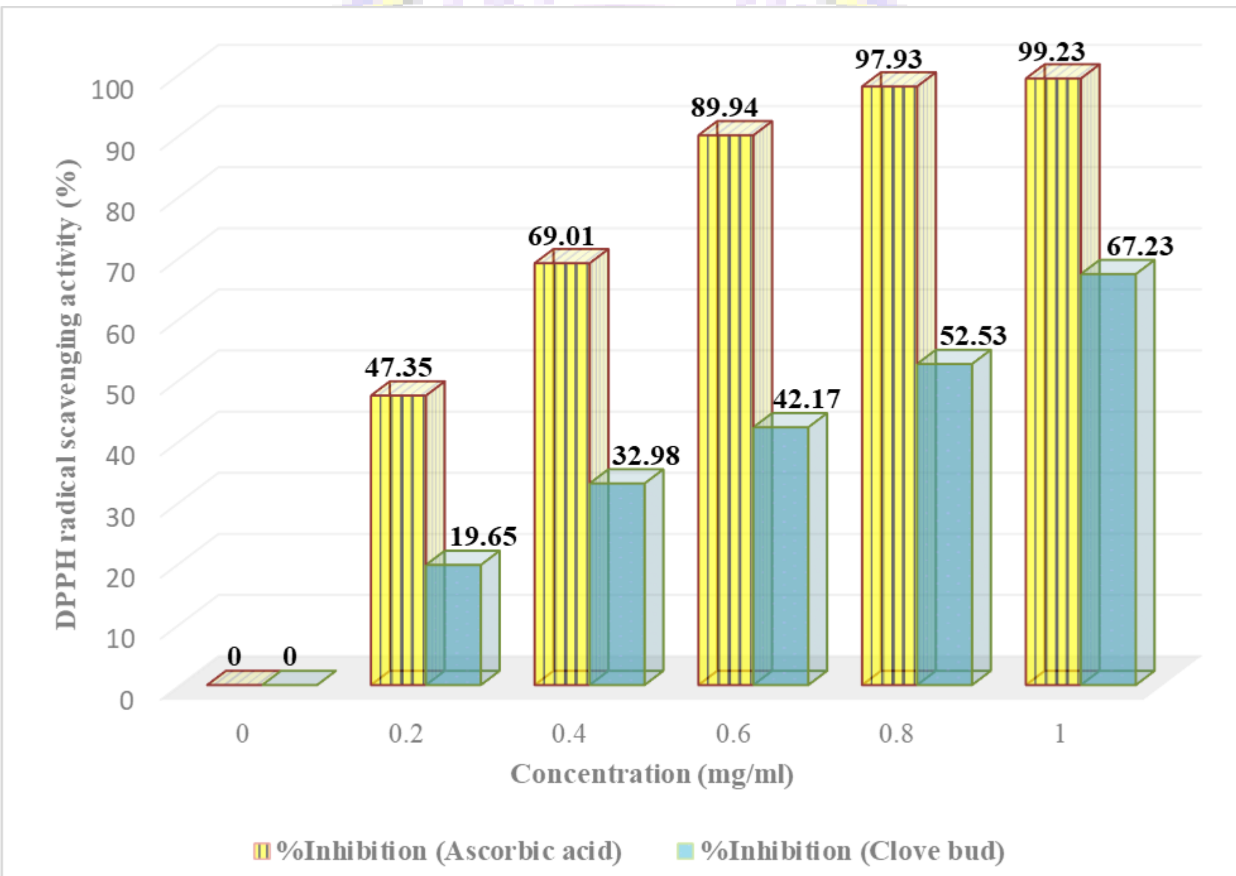

Figure 6: Clove bud antioxidant activity

CONCLUSION

The results obtained from the present study suggest that the clove bud possesses antioxidant activities and may therefore be used as a potent free radical scavenger and well as a natural preservative in food and feeds. *Syzygium aromaticum* (clove bud) may find a useful application in the management of oxidative stress-related health conditions probably in the future.

REFERENCES

Ahmed, W. (2016). Monitoring antioxidant and antityrosinase activity of clove aromatic flower buds. *Journal of Medicinal Plants Studies*, 4, 163-169.

Cortés-Rojas, D. F., de Souza, C. R. F., & Oliveira, W. P. (2014). Clove (*Syzygium aromaticum*): a precious spice. *Asian Pacific Journal of Tropical biomedicine*, 4(2), 90-96.

Gaspar, E. M., Res, T., Gaspar, E. M., Duarte, R., & Santana, J. C. (2018). Volatile composition and antioxidant properties of clove products. *Biomedical Journal of Scientific and Technical Research*, 9(4), 7270-7276.

Kamatou, G. P., Vermaak, I., & Viljoen, A. M. (2012). Eugenol-from the remote Maluku Islands to the international market place: a review of a remarkable and versatile molecule. *Molecules*, 17(6), 6953-6981.

Hussain, S., Rahman, R., Mushtaq, A., & Belaskri, A. E. (2017). Clove: A review of a precious species with multiple uses. *International Journal of Chemical and Biochemical Sciences*, 11, 129-133.

Mukherjee, S., Pawar, N., Kulkarni, O., Nagarkar, B., Thopte, S., Bhujbal, A., & Pawar, P. (2011). Evaluation of free-radical quenching properties of standard Ayurvedic formulation Vayasthapana Rasayana. *BMC Complementary and Alternative Medicine*, 11, 38. https://bmccomplementmedtherapies.biomedcentral.com/articles/10.1186/1472-6882-11-38

Selles, S. M. A., Kouidri, M., Belhamiti, B. T., & Ait Amrane, A. (2020). Chemical composition, in-vitro antibacterial and antioxidant activities of *Syzygium aromaticum* essential oil. *Journal of Food Measurement and Characterization*, 14(4), 2352-2358.

45 GROWTH PERFORMANCE AND NUTRIENT DIGESTIBILITY OF RABBITS FED DIETS CONTAINING SHEA BUTTER CAKE FERMENTED WITH *ASPERGILLUS NIGER*

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Abstract
A study was carried out to evaluate the growth performance and nutrient digestibility of mixed breed weaned rabbits fed diets containing Shea butter cake fermented with Aspergillus niger. Thirty (30) rabbits of age 6 weeks were allocated to five dietary treatments. The control diet (T1) contained 0% fermented Shea butter cake, while T2, T3, T4 and T5 contained 5%,10%,15% and 20% fermented Shea butter cake. Each treatment had three (3) replicates in which two (2) rabbits were allocated per replicate in a completely randomized design. The study lasted for 8 weeks. The result of growth performance showed significant ($p<0.05$) differences in final body weight, total body weight gain, and average body weight gain. Results of nutrient digestibility also showed significant ($p<0.05$) difference in dry matter, crude protein, crude fiber, nitrogen free extract, and total digestible nutrients. It can be concluded that rabbits can tolerate and utilize up to 20% inclusion level of fermented Shea butter cake for efficient conversion to muscle, thereby increasing their live productive weight.
Keywords: Shea butter, diet, fermented, rabbits, growth, digestibility

DESCRIPTION OF PROBLEM

Animal protein intake has been reported to be dismally low in less developed countries (Denisova, 2015). Rabbits (*Oryctolagus cuniculus*) could be one of the preferred and sustainable means of producing high quality animal protein for the increasing population in countries like Nigeria and other parts of Africa. Raising rabbits is more advantageous because of their affordability, small body size, rapid growth rate, high fecundity, genetic diversity, short gestation period, adaptability to a wide range of ecological environment, ability to utilize forage and agricultural by-products (Okojie *et al*., 2004). Rabbit meat also contains high protein, low fat, low energy, and low cholesterol (Dalle zotte, 2000). Growing of rabbits is easy and has little or no religious barrier against the production and its consumption (Alemede *et al*, 2014).

The Shea tree (*Vitellaria paradoxa*) produces fruits which is cherished and eaten by humans and animals. The nuts are processed into Shea butter while the residue is known as the shea nut cake. It has been reported to contain 15.02 % CP, 26.00 % cellulose, 40 % acid detergent fibre and 29.30 % lignin (Belewu and Belewu, 2004). However, despite having good nutritional quality little research has been carried out on the utilization of Shea butter cake in growing rabbits. The presence of anti-nutritional factors like tannin and saponin could also prevent the availability of some nutrients like protein to the animal if not properly processed. As an agro-industrial by-product, Shea butter cake is a potential tropical feed resource but its optimum utilization by livestock (especially at high levels) has been hampered the presence of anti-nutritional factors (ANFs). This makes the cake unpalatable to livestock. The palatability of the cake could be improved through various processing methods such as fermentation which promotes the growth of microbes that helps break down anti-nutrients and enhance better utilization of desirable feed nutrients (Dei et al., 2007). Fermentation of crop residues using *Aspergillus niger* has been reported to enhance their nutritional quality through modification of their anti-nutritional factors (Hong *et al*., 2004; Aderemi and Nworgu, 2007; Dei *et al*., 2007).

However, despite the nutritional potentials of the shea nut cake, little information exists on its utilization by growing rabbits. Therefore, this study was undertaken to determine the growth performance and nutrient digestibility of rabbits fed diet containing Shea butter cake meal fermented with *Aspergillus niger*.

MATERIALS AND METHOD

Experimental site

This study was carried out at the Animal Production Teaching and Research Farm of the Federal University of Technology, Minna, Niger State in Nigeria. Minna is located between latitude 09^0 30^1 and 06^0 45^1 north and longitude 06^0 30^1 and 06^0 45^1 east of the equator. It falls within the southern guinea savanna agro-ecological zone of Nigeria. The mean rainfall varies from 1100 - 1600 mm and mean temperature of between 21^0c and 35^0 (FMSN, 2015).

Source of Experimental Animals

A total of thirty (30) rabbits (mixed breed and sexes) were purchased from Ministry of Livestock Bosso, Minna, Niger State.

Source and Preparation of Test Ingredient

Shea butter cake was purchased from Bida, Niger State and *Aspergillus niger* was used as the fermenting agent. The *Aspergilus niger* that was used in this study is a laboratory strain isolate that was gotten from the Biochemistry Laboratory of Federal University of Technology Minna, Niger State. The sample was fermented for 7days inside a closed container to allow effective anaerobic fermentation, with effective turning to ensure proper mixture of the *Aspergillus niger* with Shea nut cake and also to enhance the fermentation process. This procedure was as stated by David *et al*. (2003). The fermented sample was spread on a dry clean concrete ground in an open place to dry for 5days up to about 90% of the dry matter.

Experimental diet and management of rabbit

A total of thirty rabbits (30) purchased at 6 weeks of age were weighed, and then randomly allotted to five treatment groups in a Completely Randomized Design (CRD). Each treatment had three replicate with two rabbits per replicate with a total of six rabbits per treatment. The rabbits were fed diet containing Shea butter cake fermented with *aspergillus niger* at different inclusion level. The fermented Shea butter cake (SBC) was used to prepare four (4) different experimental diets except T1 **(**control diet**)** which had no inclusion level of the fermented Shea butter cake while T2 (5%), T3 (10%), T4 (15%) and T5 **(**20%) inclusion level of fermented Shea butter meal respectively. The diets were isocaloric (2900kcal/kg) and isonitrogenous (16% CP). Hutches were cleaned and equipped with feeders and drinkers prior to the arrival of the animals. The rabbits were allowed an acclimatization period of one week after purchase and were fed with commercial grower feed during this period. The rabbits were dewormed against ecto and endo-parasite before the start of the experiment.

Data Analysis

Data collected on all parameters were analyzed using one-way analysis of variance (SPSS, 2006). Where there were significant differences ($P<0.05$), Duncan test for multiple comparisons was used to separate the means.

RESULTS AND DISCUSSION

The proximate composition of diets containing shea butter cake fermented with *Aspergillus niger* is shown on table 1. The result indicated that T3 had the highest values for dry matter (94.60 %) while the lowest value was recorded at T5 (90.00 %). Crude protein content of the diets ranged from 15 % to 16 %.

T5 had the highest crude fibre (22.50 %) while T1 had the least crude fibre content (19.00 %). Ether extract content of the diets ranged from 7.50 % to 14.00 % with T4 having the most of these nutrients. The ash content of the diet was lowest at T1 (4.5 00 %) and highest at T3 (7.00 %). Nitrogen free extract (NFE) was most abundant in the control diet, T1 (43.25 %) while the least NFE values were recorded in T3 (38.60 %).

Table 1: Proximate composition of diets containing shea butter cake fermented with *Aspergilus niger*

Parameters	T1	T2	T3	T4	T5
Dry matter	90.00	90.20	91.20	94.60	90.60
Crude protein	15.75	15.75	16.10	16.10	16.10
Crude fibre	19.00	20.00	20.00	21.50	22.50
Ether extract	7.50	7.50	9.50	14.00	12.50
Ash	4.50	6.50	7.00	6.00	5.50
NFE	43.25	40.45	38.60	37.00	34.00

T1: 0% Fermented shea butter cake inclusion, T2: 5% fermented shea butter cake inclusion, T3: 10% fermented shea butter cake inclusion, T4: 15% fermented shea butter cake inclusion, T5: 20% fermented shea butter cake inclusion SBC: Shea Butter Cake

Growth performance of the rabbits fed diets containing shea butter cake fermented with *Aspergilus niger* is shown on Table 2. The final body weight, total body weight gain, and average body weight gain were significantly ($p<0.05$) influenced by the dietary treatments. However, initial body weight, feed conversion ratio, average feed intake, protein efficiency ratio, and energy efficiency ratio were not significantly ($p>0.05$) influenced by the dietary treatment. Rabbits in T3 (10 % fermented Shea nut cake) had the highest ($P<0.05$) final body weight (1775 g) while the body weight values for other treatment groups were statistically similar.

The impressive body weight recorded in T3 could be as a result of the higher feed intake observed relative to other treatment groups. This improved feed intake may have promoted consumption of adequate quantity of nutrients in the feed which may have positively affected the rabbits in enhancing live weight Fermentation promotes the growth of microbes which partake in vital processes in the body of animals (Dei *et al*., 2007). The better weight gain in T3 (10 % fermented Shea nut cake) could also be due to the fact that sufficient amount of protein was supplied into the small intestine and this may have enhanced the level of microbial protein synthesis in gut leading to improvement in live weight. This also agrees with the findings of Belewu *et al*. (2003) who reported improved weights when fungus-treated crop residues were administered to goats.

The result on Table 3 shows that the nutrient digestibility of the rabbits were significant ($P<0.05$) in dry matter, crude protein, crude fibre, nitrogen free extract and total digestible nutrient. However, ether extract and ash were statistically similar ($P> 0.05$). The high digestibility of dry matter, crude protein and crude fibre in T5 (20 % fermented Shea butter cake) could be due to the fact that *Aspergillus niger* degraded the antinutritional factors in the diet before it was fed to the rabbits. This corroborates the findings of Jacquiline and Vesser (1991) who reported that structural modification of feed proteins enables degradation of antinutritional factors in the feed.

Table 2: Growth performances of rabbits fed diets containing shea butter cake meal fermented with *Aspergilus niger*

Parameters	T1	T2	T3	T4	T5	SEM	LOS
Initial body weight (g)	620.00	616.67	600.00	622.50	622.50	5.18	NS
Final body weight (g)	1592^{b}	1417^{b}	1775^{a}	1492^{b}	1525^{b}	38.64	*
Total weight gain (g)	971.67^{ab}	800.00^{b}	1148^{a}	891.67^{b}	915.00^{b}	40.45	*
Average weight gain/Wk	121.46^{ab}	100.00^{b}	143.54^{a}	111.46^{b}	114.38^{b}	5.06	*
Average feed intake/Wk	359.43	380.75	407.37	344.45	348.59	12.84	NS
Feed Conversion Ratio	2.96	3.89	2.85	3.09	3.07	0.17	NS
Protein Efficiency Ratio	16.93	13.62	17.61	16.40	16.31	0.64	NS
Energy Efficiency Ratio	0.93	0.74	0.96	0.89	0.88	0.35	NS

^{ab}: means in the row with different superscript are significantly ($p<0.05$) different; SEM: Standard Error Mean; LOS: Level of Significance, *Significant, NS: Not Significant, T_1: 0% Fermented shea butter cake inclusion, T_2: 5% fermented shea butter cake inclusion, T_3: 10% fermented shea butter cake inclusion, T_4: 15% fermented shea butter cake inclusion, T_5: 20% fermented shea butter cake inclusion, SEM: Standard error of means, LOS: Level of significance

Table 3: Nutrient digestibility of rabbits fed diet containing Shea butter cake fermented with *Aspergillus niger*

Parameters	T1	T2	T3	T4	T5	SEM	LOS
Dry matter	81.67^{a}	76.93^{a}	75.46^{ab}	72.85^{b}	82.38^{a}	1.31	*
Crude protein	71.51^{a}	71.98^{a}	65.76^{ab}	56.96^{b}	73.23^{a}	2.08	*
Crude fibre	84.47^{ab}	86.65^{a}	78.26^{b}	70.32^{c}	87.04^{a}	1.86	*
Ether extract	83.89	88.78	86.89	75.72	90.28	2.95	NS
Ash	43.78	88.78	51.31	34.88	52.86	2.98	NS
NFE	87.83^{a}	76.36^{c}	80.36^{bc}	80.64^{bc}	85.51^{ab}	1.28	*
TDN	79.46^{ab}	74.54^{b}	75.83^{ab}	77.98^{ab}	85.84^{a}	1.56	*

abc :means in the row with different superscript are significantly($p<0.05$)different; LOS: Level of Significance, *Significant, NS: Not Significant,TDN: Total Digestible Nutrient; NFE: Nitrogen Free Extract; SBC: Shea Butter Cake, T1: 0% Fermented Shea butter cake inclusion,T2: 5% fermented Shea butter cake inclusion, T3:10% fermented Shea butter cake inclusion, T4: 15% fermented Shea butter cake inclusion, T5: 20% fermented Shea butter cake inclusion, SEM: Standard error of means, LOS: Level of significance

CONCLUSIONS

Based on the study, it can be concluded that weaned rabbits can tolerate up to 20% inclusion of shea butter cake fermented with *Aspergillus niger* in their diets without extreme adverse effects on growth performance.

REFERENCES

Aderemi, F.A. and Nworgu, F.C. (2007). Nutritional status of cassava peels and root sieviate biodegraded with *Aspergillus niger*. *American-Eurasian Journal of Agriculture and Environmental studies,* 2: 308-311

Alemede, I.C., Onyeji, E.A., Tsado, D.N. and Shawoya,E.L. (2014). Reproductive response of rabbit does to diets containing varying levels of Horseradish (Moringa oleifera) leaf meal. *Journal of Biology, Agriculture and Healthcare* 4(19): 62-68

Belewu, M.A. and Belewu, K.Y. (2004). Biodegradation of tannins in shea butter cale and leaves.

In: proceedings of the 17th Annual Conference of the Biotechnology Society of Nigeria, Ado-Ekiti, Ekiti State, Nigeria

Belewu, M.A., Yousuf, M.B. and Afolabi, E.O. (2003). Nutritional Evaluation of Graded Levels of *Aspergillus*-treated rice husk on the performance characteristics of pregnant WAD goats. *International Journal of Agricultural Science and Rural Development,* 4: 87-91

Dalle zotte, A. (2000). Main factors influencing rabbit carcass and meat quality. Proceedings of the 7th World Rabbit Congress (Valencia, Spain), 1-32

David, H. Akesson, M. and Nielson, J. (2003). Reconstruction of the central carbon metabolism of *Aspergillus niger*. *European Journal of Biochemistry,* 270 (21): 4243-4253

Dei, H.K. Rose, S.P. and Mackenzie, A.M. (2007). Shea nut (*Vitellaria paradoxa*) meal as a feed ingredient in Poultry. World Poultry Science Journal, 63 (4): 611-624

Denisova, T.S. (2015).Nigeria 2015: Leadership Change. Asia and Africa today, 8: 12-17

FMSN (2015). Federal Meteorological Station, Niger State. International Airport Weather Report (Unpublished)

Hong, K.J., Lee, C.H. and Kim, S.W. (2004). Aspergillus oryzae BG-107 fermentation improves nutritional quality of food soybean and feed soybean meals. *Journal of Medicinal Foods,* 7:430-435

Jacqueline, E.W., and Vesser, B. (1996). Assessing the Potential in Biotechnology: Building on Farmers' Knowledge, CTA. Edited by Joske, B. Bertius

Maertens, L. and Struklec, M. (2010). Technical note: Preliminary results with a tannin extract on the performance and mortality of growing rabbits in an enteropathy infected environment. *World Rabbit Science,* 14 (3): 189-192

Okojie, L.O., Ayinde, I.A. & Alli, A.O. (2004). Economic analysis of rabbit production: on-farm research approach. *Nigerian Journal of Animal Production,* 31(2): 230-236

Parisi, F., Mancini, P., Mazzei, M., Forzan, M., Turchi, B., Perruci, S., Poli, A. and Paci, G. (2018). Effects of dietary supplementation of a mix of chestnut and Qnebracho tannins on intestinal morphology bacterial load, *Eimeria spp* oocyst excretion and immune response after vaccination in rabbits. *American Journal of Animal and Veterinary Science,* 13 (3): 94-103

SPSS (2006). Statistical Programme for Social Sciences. SPSS for windows. Release 2006, SPSS Inc.

46 MEAT QUALITY CHARACTERISTICS OF WEANER RABBITS FED DIETS CONTAINING SHEA BUTTER CAKE FERMENTED WITH *Aspergillus niger*

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Abstract

The study was conducted to evaluate the meat quality characteristics of weaner rabbits fed diet containing Shea butter cake fermented with Aspergillus niger. Thirty (30) rabbits of age 6 weeks were allocated to five dietary treatments. The control diet (T1) contained 0% fermented shea butter cake, while T2, T3, T4 and T5 contained 5%, 10%, 15% and 20% fermented shea butter cake. Each treatment had three (3) replicates with two (2) rabbits in each replicate allotted in a completely randomized design. The study lasted for 8 weeks. Determination of meat quality characteristics were carried out. The result showed variations in quality parameters across treatment groups. Cooking yield was significantly higher (P<0.05) in rabbits fed 20% fermented shea butter cake. There were significant differences (P<0.05) in juiciness, flavor, tenderness, overall acceptability, moisture and crude protein content in rabbits fed 15 % Shea butter cake fermented with Aspergillus niger (T3) compared with the control group (T1). Based on the findings of this study, it was concluded that 15 % inclusion level of Shea butter fermented with Aspergillus niger give the best meat qualities characteristics in terms of juiciness, flavour, tenderness, crude protein content and overall acceptability.
Keywords: Meat, Shea butter, diet, fermented, rabbits

DESCRIPTION OF PROBLEM

There is an increased interest in meat from other animal species, due to some reasons which includes quality of meat, ease of breeding, total meat production and availability of animal species. These sources of meat include fallow deer, horses, pigeon, ostrich, and rabbits (Poławska *et al*., 2013). Rabbit (*Oryctolagus cuniculus*) has been identified as a promising way of alleviating and bridging the massive gap in animal protein deficiency in Nigeria. They can produce about 20.80% protein levels (Biobaku and Oguntona, 1997) and about 47 kg of meat per doe yearly (Kalio *et al*., 2008). Rabbits maximally convert feed to meat and can use up to 30 % crude fiber as against 10 % by most poultry species due to the presence of caeca microbes which is absent in most non-ruminant species (Vantus *et al*., 2014). Nutrition is a key component of animal production system which controls several aspect of meat quality. Such qualities as meat tenderness, bright attractive colours, affordability and low fat have brought about different feed regimes (Kandepan *et al*., 2009).

Shea butter cake is a by-product of Shea butter industry extracted from Shea nut (*Vitellaria paradoxa*, Gaertner or *Butyrospermum parkii*, Kotschy). It is used internationally in the production of chocolate, sweets, baking fat and cosmetics. The cake contains some fibre, cellulose, lignin and acid detergent fibre (Dei *et al*., 2008). The high content of anti-nutritional factors such as tannins, saponins and hydrogen cyanide makes it unpalatable to animals and as well masking the nutrient content of the cake. The percentage of these tannins can be reduced by fermentation (Reddy and Pierson, 2004).The fermentation process can create conditions for the growth of microbes (*Bacillus, Corynebacterium, Klebsiella, Aspergillus, Psenicillium, Fusarium, and Candida*) that break down these tannins (Reddy and Pierson, 1994). The type of feed offered to animals during the rearing phase has a great influence on the quality of the final product. In rabbits, the influence of feed on meat quality characteristics can be affected by gender (sex) of rabbits (Trocino *et al*., 2018). Information on carcass characteristics of rabbis fed non-conventional feedstuff is therefore helpful for the effective utilization of rabbit meat. This study was therefore designed to evaluate the effect of sex on meat quality characteristics of weaner rabbits fed diet containing Shea butter cake fermented with *Aspergillus niger*.

MATERIALS AND METHODS

Experimental Site

This study was carried out at the Animal Production Teaching and Research Farm of the Federal University of Technology, Minna, Niger State in Nigeria. Minna is located between latitude 09^0 30^1 and 06^0 45^1 north and longitude 06^0 30^1 and 06^0 45^1 east of the equator. It falls within the southern guinea savanna agro-ecological zone of Nigeria. The mean rainfall varies from 1100 - 1600 mm and mean temperature of between 21^0c and 35^0 (FMSN, 2015).

Source and Preparation of Experimental Materials

Thirty weaned (5 – 6 weeks old) rabbits weighing 600g were purchased from a rabbit farm in Minna metropolis, Niger state, Nigeria. Shea butter cake was collected from a dumping site around Bida area of Niger State. *Aspergillus niger* was used as the fermenting agent. The *Aspergillus niger* used in this study was a laboratory strain isolate obtained from the Biochemistry Laboratory of Federal University of Technology Minna, Niger State. The samples were fermented for 7 days inside a closed container to allow effective anaerobic fermentation. This was done following the protocol described by David *et al*. (2003). The fermented samples were spread on a polythene sheet in an open place and dried for a period of five days until a steady moisture content of 10 % was attained.

Management of Rabbits/Experimental Diets

Thirty rabbits were randomly allotted to five (5) dietary treatment groups in a completely randomized design (CRD). Each treatment had 3 replicates with 2 weaned rabbits per replicate. The rabbits were fed *ad-libitum* throughout the experimental period. Five diets were formulated and each contained Shea butter cake fermented with *Aspergillus* niger in varying proportions. T1 contained 0% inclusion of fermented Shea butter cake and T2 – T5 contained 5%, 10%, 15% and 20% of the fermented Shea butter cake respectively. The diets were formulated to contain a crude protein of 16% and a metabolizable energy of 2900kcal/kg.

Data Collection and Analysis

At the end of the growth studies, 2 rabbits were selected from each treatment for meat quality and sensory characteristics. The water holding capacity, meat pH, cooking loss, sensory evaluation and proximate composition of the meat samples were determined. All data collected were subjected to Analysis of Variance (ANOVA) using SAS (1998).

RESULTS AND DISCUSSION

There were some variations in quality parameters due to the effects of the experimental diets. Meat from rabbits in T1 (0% shea butter cake) had significantly ($p<0.05$) higher water holding capacity and cooking loss compared with other treatment groups. However, pH was higher at T1 while cooking yield was best in rabbits fed T5 diets (Table 1). The higher cooking loss observed at T1 could be due to the quality of the meat samples prior to cooking. This is in agreement with the findings of Fakolade (2007) who reported that cooking losses in meat depends largely on the quality of meat before cooking. In this study, there is a positive correlation between pH and colour of the meat. At T3 meat samples with the highest pH also showed higher values for colour. This could be that the colour of rabbit meat is positively correlated to its pH

Table 1: pH, WHC, CY and CL of rabbit fed shea butter cake fermented with *Aspergillus niger*

Parameters	T1	T2	T3	T4	T5	SEM	P-VALUE
pH	7.11^{b}	7.12^{b}	7.20^{a}	7.18^{a}	7.11^{b}	0.02	0.001
WHC	45.20^{a}	43.10^{b}	28.15^{e}	36.65^{d}	40.70^{c}	0.23	0.001
CY	71.54^{e}	80.02^{c}	80.44^{b}	75.96^{d}	82.85^{a}	0.07	0.001
CL	28.46^{a}	19.98^{c}	19.56^{d}	24.05^{b}	17.15^{e}	0.07	0.001

[abcd]: means with different superscripts in the same column are significantly($p<0.05$) different. WHC:Water holding capacity, CY:Cooking yield, CL: Cooking loss T1= 0% fermented shea butter cake, T2 =5% fermented shea butter cake , T3=10% fermented shea butter cake, T4= 15 % fermented shea butter cake, T5=20% fermented shea butter cake

Table 2: Sensory properties of rabbits fed shea butter cake fermented with *Aspergillus niger*

Parameter	T1	T2	T3	T4	T5	SEM	P-VALUE
Colour	6.81	6.40	6.37	6.87	6.56	1.02	0.14
Juiciness	6.90^{ab}	6.08^{c}	6.40^{bc}	7.23^{a}	6.46^{bc}	1.17	0.01
Flavour	6.69^{ab}	6.27^{b}	6.56^{ab}	6.88^{a}	6.34^{ab}	1.00	0.12
Tenderness	6.83^{ab}	6.50^{ab}	6.67^{ab}	7.12^{a}	6.46^{b}	1.16	0.15
Overall acceptability	7.37^{a}	6.67^{b}	7.19^{ab}	7.32^{a}	6.98^{ab}	1.07	0.05

[abcd]: means with different superscripts in the same column are significantly ($p<0.05$) different, SEM: Standard error of mean T1= 0% fermented shea butter cake, T2 =5% fermented shea butter cake , T3=10% fermented shea butter cake, T4= 15 % fermented shea butter cake, T5=20% fermented shea butter cake

Table 3: Proximate composition of meat from the hind leg of rabbits fed shea butter cake fermented with *Aspergillus niger*

Parameters	T1	T2	T3	T4	T5	SEM	P-VALUE
Moisture	28.21^{b}	30.30^{ab}	33.57^{a}	32.09^{a}	32.09^{a}	3.10	0.171
Crude Protein	31.50^{c}	35.88^{b}	35.35^{b}	41.13^{a}	28.73^{d}	2.22	0.001
Ash	1.00^{a}	0.50^{b}	0.50^{b}	1.00^{a}	1.250^{a}	0.68	0.002
Ether extract	25.00	25.00	26.00	26.00	25.75	2.02	0.901

^{abcd}: means with different superscripts in the same column are significantly (p<0.05) different, CP: crude protein, EE: Ether extract, SEM: standard error of mean, SEM: Standard error of mean, T1= 0% fermented shea butter cake, T2 =5% fermented shea butter cake , T3=10% fermented shea butter cake, T4= 15 % fermented shea butter cake, T5=20% fermented shea butter cake

Results of the sensory properties of meat from rabbits fed different levels of shea butter cake fermented with *Aspergillus niger* is presented on Table 2. There were significant differences (P<0.05) in juiciness, flavour, tenderness and overall acceptability. However, the values for meat colour were statistically similar. Water holding capacity was highest at the T1 (45.20) and lowest at T3 (28.15). Also, cooking loss was highest at T1 (28.46) and lowest at T5 (17.15). Water holding capacity is often linked with juiciness in meats. Responses from the panelists in this study did not reflect this assertion. This may be attributed to the high cooking loss recorded at T1 which may have affected the juiciness of the meat

The proximate composition of meat from hind leg of the rabbits (Table 3) showed that moisture and crude protein were significantly (p<0.05) influenced by the diets. Moisture and crude protein were higher in rabbits fed fermented Shea butter cake (T2, T3, T4 and T5) compared with the control (T1). The high crude protein of the meat could be attributed to the activities of fermentation microbes in the feed. This corroborates earlier reports that fermentation which promotes the growth of microbes and enhance better utilization of desirable feed nutrients (Dei et al., 2007).

CONCLUSIONS

Based on the findings of this study, it was concluded that raising rabbits with 15 % inclusion level of shea butter cake fermented with *Aspergillus niger* will give the best meat qualities characteristics. It is recommended that more research should be carried out to determine the economic profitability and health benefit of feeding rabbit on shea butter cake fermented with *Aspergillus niger*.

REFERENCES

Biobaku, W.O. and Oguntona, E.B. (1997). The effects of feeding multi-nutrient Mini Blocks and Pelleted diets on the growth of rabbits. *Nigerian Journal of Animal Production*, 24 (2): 147-149

David, H. Akesson, M. and Nielson, J. (2003). Reconstruction of the central carbon metabolism of Aspergillus niger. *European Journal of Biochemistry*, 270 (21): 4243-4253.

Dei, H.K. Rose, S.P. and Mackenzie, A.M. (2007). Shea nut (*Vitellaria paradoxa*) meal as a feed ingredient in Poultry. World Poultry Science Journal, 63 (4): 611-624.

Fakolade, P.O. (2007). Physical characteristics of camel muscle compared with three breeds of cattle. *International Journal of Applied Agriculture and Agricultural Research*, 1: 14-19.

FMSN (2015). Federal Meteorological Station, Niger State. International Airport Weather Report (Unpublished)

Kalio, G., Etela, I. and Cinikia, V. (2008). “Rabbit meat as a preferred animal protein source in Ekpeye kingdom of Rivers State, Nigeria”. *Livestock Research for Rural Development*, 20 (1): 1-7.

Kandepan, G., Anjaneyulu, A.S.R., Rao, V.K., Pal, U.K., Mondal, P.K. and Das, C.K. (2014). Feeding regimens affecting meat quality characteristics. MESO, 11 (4): 240-249.

Polawska, E., Cooper, R.G., Jozwik, A. and Pomianowski, J. (2013). Meat from alternative species- nutritive and dietetic value, and its benefit for human health – a review. *Cyta-Journal of Food*, 11:37-42.

Reddy, N.R. and Pierson, M.D. (1994). Reduction in antinutritional and toxic components in plant foods by fermentation. *Food Research Internationational*, 27: 281-287.

SAS (1998). Statistical Analysis System Institutute, Users guide. SAS Institute Inc. Cary, N. C.

Trocino, A., Birolo, M., Dabbou, S., Gratta, F., Rigo, N. and Xiccato, G. (2018). Effect of age and gender on carcass traits and meat quality of farmed brown hares. *Animals*, 12 (4): 864-871.

Vantus, V.B., Kovacs, M. and Zsolnai, A. (2014). The rabbit caecal microbiota: development, composition and its role in the prevention of digestive diseases – a review on recent literature in the light of molecular genetics methods. *Acta Agraria Kaposvariensis*, 18 (1): 55-65.

Warner, R.D. (2017). The eating quality of meat – IV Water Holding Capacity and Juiciness. *Lawries Meat Science*, 8: 419-459.

47 GROWTH PERFORMANCE AND CORRELATION MATRIX OF SAVANNA BROWN GOATS FED ENZYME TREATED SAWDUST DIETS AS REPLACEMENT FOR MAIZE OFFAL

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Abstract

This study was conducted to determine the growth performance and correlation matrix of Savanna Brown goats fed enzyme treated sawdust diets managed semi-intensively. A total of thirty (30) goats weighting between 5.8 and 7.3 kg were arranged in a completely randomized design. The animals were divided into five dietary treatments (T) groups with three replications. Treatment one (T1) comprises of animals fed 0 % enzyme treated sawdust diet while Treatment 2 (T2), Treatment 3 (T3), Treatment 4 (T4) and Treatment 5 (T5) comprises of animals fed diets containing 10, 20, 30 and 40 % enzyme treated sawdust diets respectively. Data on growth performance parameters and correlation matrix were measured. All data collected were analyzed using one way analysis of variance. No significant difference (p>0.05) was observed among the treatment groups in all growth performance parameters. However, chest girth was found to be most correlated to body weight (1.00) and this was observed in SBG fed 40 % enzyme treated sawdust diet. It was, therefore, concluded that enzyme treated sawdust can be used in the diets of Savanna Brown goats up to 40 % replacement for maize offal and chest girth can be used to predict the body weight of savanna brown goat.

Keywords: sawdust diets, Savanna Brown goat, growth performance, correlation matrix

INTRODUCTION

The population of goats in Nigeria is about 53.8 million and they serves as sources of meat and milk for local consumptions as well as hides for export earnings. Ruminant animals feed mainly on forages such as crop residues and pastures obtained from rangelands (Anifowose *et al*., 2016). These forages are scarce, especially, during drought period resulting to malnourishment and reduce productivity in ruminant animals. The poor quality of feed resources in the tropics was reported by Leng (1990) who observed that ruminant feeding in the tropics and subtropics considerably depended on low-quality materials (i.e. grazing pastures and crop residues) and also, despite the adaptation of most of indigenous animals to the nutrient stress, it can be argued that these adaptation mechanisms are only often sufficient to balance nutrient requirements for maintenance. This leads to poor productive and reproductive performance of the animals. Supplementation with protein and energy diets is, therefore, common strategies often used in improving ruminant productivity. The supplementation strategies have ranged from aiming at improving intake of plant material with higher anti-nutritional factors (Dziba *et al*., 2007) and improving fibrous feed utilization (Leng, 1990). Sawdust is one of such fibrous feed resources.

Sawdust is a by-product of sawmill industries and is made up of cellulose, lignin and hemicellulose. Treatment of sawdust may assist in degrading lignin, cellulose and hemicellulose to usable materials that can be utilized by ruminant animal (Akinfemi and Ladipo, 2013).

Several researches have demonstrated the beneficial effects of supplementing ruminant diets with exogenous enzymes more specifically, exogenous fibrolytic enzymes in means of improving fiber digestibility and consequently, the efficiency of feed utilization by ruminants in *in-vitro* (Azzaz, 2009) and *in-vivo* (Arriola *et al*., 2011).

This experiment was, therefore, aimed at determining the effect of enzyme degraded sawdust-based diets on the growth performance and body linear measurement of Savanna Brown goats under semi-intensive management system.

MATERIALS AND METHODS

Location of the Study

The study was conducted at the Teaching and Research Farm of the Department of Animal Production, Federal University of Technology Minna, Nigeria. Minna is situated between latitude 9° 31 ¹ and 9° 45 ¹ North and longitude 7° 31 ¹ and 6 ° 45 ¹ East, it has an altitude of 75 m above sea level and located in the Southern Guinea Savanna zone, with temperature range of 38 – 40 degree centigrade, the annual rainfall ranges from 1,200 to 1,300 mm and has two (2) seasons of wet from April to October and dry from November to March (Climatemp, 2019).

Experimental Animals, Management and Design

A total of 30 Savanna Brown goats were used in this study, they had weights ranging from 5.7 to 7.2 kg, and were sourced from within Minna. They were managed semi-intensively, concentrate diets were offered at 1.5 % body weight in the morning, between the hours of 7 and 9 am before they are allowed to go out for grazing from 9 am to 5 pm and 1.5 % of body weight of concentrates feed in the evening after grazing as recommended by Mamoon (2008). Fresh water was provided *ad libitum.*

The goats were randomly allotted to five dietary treatments with six goats per treatment and each treatment group were replicated thrice with two goats per replicate. Treatment 1 is the control with 0 % inclusion of xylanase and cellulase enzymes treated sawdust meal, while, Treatments 2, 3, 4 and 5, contained 20, 30 and 40 % inclusion of xylanase and cellulase enzymes treated sawdust meals, respectively. Completely randomized design (CRD) was used for this experiment.

Data Collection

Initial live weights of the goats were taken at the commencement of the experiment while correlation matrix was calculated. Weekly mean live weights, feed intakes, were taken until termination of the experiment which lasted for four (4) months. Daily mean live weights and feed intakes were calculated from the weekly measurements. Feed conversion ratios and correlation matrix were also calculated.

Feed intake, Body weight and

Daily feed intake was measured by subtracting the leftover feed from the total feed given to the animals per head per day. Body weight (kg) was taken using weighing scale.

Results and discussion

The growth performance of Savanna Brown goats fed enzyme treated sawdust diets as replacement for maize offal managed semi-intensive system is presented in Table 1. The results showed no significant ($p>0.05$) difference in all parameters measured across all the treatment groups. This, however, disagrees with Salim *et al.* (2003) who observed significant difference in live weight gain when goats and sheep were given supplement diet under grazing condition. The results are also not in line with the report of Wahyuni *et al*. (2012) who observed that enzyme supplementation in the diets of goats result in higher average daily gain. The no significant difference observed in total feed intake and average feed intake in this experiment agrees with Wahyuni *et al*. (2012) who reported that enzyme supplementation did not affect dry matter intake, this could mean that the diet was accepted by the animals.

Table 2 shows the results of correlation matrix between body weight and body linear measurement of Savanna Brown goats fed enzyme treated sawdust based diets as replacement for maize offal managed under semi-intensive system. Positive and significant ($p<0.01$) correlations were observed between body weight and other body linear measurements. The highest correlation (1.00) was observed between body weight and chest girth in animals fed 40 % enzyme treated sawdust diets, these suggest a positive effect of treated sawdust in the diets and can be used to predict the live weight of Savanna Brown goats under semi-intensive management. This result disagrees with the report of Babale *et al*. (2015) who reported no significant correlation between body weight and chest girth when they replace corn cobs for maize bran with cowpea husk as basal diets to check the performance and linear body measurement of Red Sokoto male goats managed intensively. This might be because their study was done under intensive management. However, this result is in the line with the result of Dereje *et al.* (2013) who reported significant correlation between body weight and heart girth for both male and female Haraghe highland goats.

Table 1: Growth performance of Savanna Brown Goat fed Enzyme Treated Sawdust Based Diets as Replacement for Maize Offal Managed under Semi-intensive System

Parameters (g)	T_1	T_2	T_3	T_4	T_5	SEM	p-value
Initial body weight	7250.00	6500.00	6375.00	6500.00	5750.00	275.00	0.60
Final body weight	9475.00	10125.00	9825.00	9150.00	8500.00	296.40	0.50
Total body weight gain	2225.00	3625.00	3250.00	2650.00	2750.00	199.60	0.20
Average daily weight gain	22.70	36.99	33.16	27.04	28.06	2.04	0.20
Average total feed intake	2952.03	3089.63	3335.03	2978.65	3091.50	76.70	0.58
Average daily feed intake	210.86	220.69	238.22	212.76	220.82	5.48	0.58
Feed conversion ratio	11.41	6.34	7.29	8.56	8.04	0.74	0.26

Keys
T_1 = 0 % Inclusion of enzyme-treated sawdust
T_2 = 10 % Inclusion of enzyme-treated sawdust
T_3 = 20 % Inclusion of enzyme-treated sawdust
T_4 = 30 % Inclusion of enzyme-treated sawdust
T_5 = 40 % Inclusion of enzyme-treated sawdust
SEM = Standard error of Mean

Table 2: Correlation Matrix of Savanna Brown Goat Fed Enzyme Treated Sawdust Based Diets as Replacement for Maize Offal Managed under Semi-intensive System

PARAMETERS	T1	T2	T3	T4	T5
Body weight and Height at withers	0.85**	0.95**	0.86**	0.91**	0.99**
Body weight and Body length	0.84**	0.91**	0.88**	0.93**	0.98**
Body weight and Chest girth	0.87**	0.91**	0.90**	0.92**	1.00**
Body weight and Hind leg length	0.87**	0.93**	0.90**	0.94**	0.99**
Body weight and Fore leg length	0.88**	0.93**	0.90**	0.93**	0.99**
Body weight and Facial length	0.85**	0.91**	0.89**	0.95**	0.99**

** Correlation is significant at 0.01 level (2-tailed)

CONCLUSION AND RECOMMENDATION

The findings of this study demonstrated that enzyme treated sawdust can be used in the diets of Savanna Brown goats up to 40 % replacement for maize offal and chest girth can be used to predict the body weight of savanna brown goat.

REFERENCE

Akinfemi, A. & Ladipo, M. K. (2013). Bioconversion of *Daniellia oliveri* Tree Sawdust into Ruminant Feed. *PAT (1):105-113 ISSN: 0794-521.3 www.patnsukjournal.net/currentissue*

Anifowose, T. A., Mustapha, Y., Manu, I. & Njidda, B. (2016). Nutrient intake, digestibility and nitrogen balance in Red Sokoto bucks fed different ratios of guinea grass (*Panicum maximum*) : cowpea (*Vigna unguiculata* (L) Walp) shells diets. *Journal of Agriculture and Food Science* 42(2):11-16.

Arriola, K.G., S.C. Kim, C.R. Staples and A.T. Adesogan, 2011. Effect of fibrolytic enzyme application to low- and high-concentrate diets on the performance of lactating dairy cattle. *Journal of Dairy Science*, 94: 832-841.

Azzaz, H.H., 2009. Effect of cellulytic enzymes addition to diets on the productive performance of lactating goats. M.Sc. Thesis, Faculty of Agriculture, Cairo University, Egypt.

Babale, D. M., Kibon, A. & Yahaya, M. S. (2015). Performance and linear body measurements of Red Sokoto male goats on replacement levels of corn cobs for maize bran with cowpea husk basel diet. Net. *Journal of Agricultural Science* 3(2): 35-40

Climatetemp. Minna climate information (2019). Retrieved on 28th May, 2009, from http://www.climatetemp.info /nigeria/minna.htm

Dereje, T., Berhanu, B. & Aynaien, H. (2013). Linear body measurements as predictor of body weigth in Haraghe highland goats under farmers environment, *Ethiopia*, *Global Veterinarian* 11(5): 649-656

Dziba, L. E., Provenza, F. D., Villalba, J. J. & Atwood, S. B., (2007). Supplemental energy intake, digestibility and body weight change. *Animal Feed Science Technology* 85, 239 -257.

Leng, R. A. (1990). Factors affecting the utilization of poor quality forage by ruminants particularly under tropical conditions *Nutritional Research Review*. 3: 277 – 303.

Mamoon, R. (2008). Goats and their nutrition. Manitoba goat Association. Covering New ground. Manitica Agricultural sustainability initiative. WWW.Manitobagoat. Com

Salim, H. M., Shahjalal, M., Tareque, A. M. M. & Akter, N. (2003). Intake and growth performance of female goats and sheep given concentrate supplement under grazing condition. *Pakistan Journal of Biological sciences* 6(15): 1304-1309.

Wahyuni, R. D., Ngampongsai, W., Wattanachant, C., Visessanguan W. & Boonpayung, S. (2012). Effects of enzyme levels in total mixed ration containing oil palm frond silage on intake, rumen fermentation and growth performance of male goat. Songklanakarin *Journal of Science Technology* 34: 353-360.

48 EFFECT OF BODY WEIGHT AND METHOD OF CASTRATION ON THE COLD AND HOT CARCASS CHARACTERISTICS OF SAVANNA BROWN GOATS

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Abstract

This study was carried out to determine the influence of body weight and method of castration on the hot and cold carcass characteristics of Savanna Brown goats. A total of twenty-four (24) animals weighing between 4-8 kg and 8-12 kg were used. The goats were randomly allotted to six (6) treatments (T_1-T_6) with four (4) goats per treatment. Each treatment had two (2) replicates with two (2) goats per replicate. T_1-T_3 were goats weighing between 4-8 kg and T_4-T_6 were goats weighing between 8-12 kg; with T_2 and T_4 having goats with open castration method (surgical) while T_3 and T_5 had goats with close castration method (Burdizzo). Treatment T_1 and T_6 were non castrates. The experiment lasted for fourteen (14) weeks during which data were collected on feed intake and body weight gain. At the end of the feeding trial, two (2) animals per treatment were slaughtered, eviscerated and dressed. Data collected were subjected to one-way analysis of variance (ANOVA) procedure of SAS (2002), based on a completely randomized design model, using a 3×2 factorial arrangement. Results obtained revealed that close castrates had significant performance over open castrates and non-castrates in both hot and cold carcass percentage. Similarly, goats weighing between 4-8 kg had significantly higher percentage (%) of both hot and cold carcasses. It can be concluded that weight and method of castration had significant effect on the hot and cold carcass characteristics of Savanna Brown goats.

Keywords: Body weight; castration; carcass characteristics.

INTRODUCTION

The potential of goat production in alleviating the low level of consumption of animal protein by human beings in developing nations such as Nigeria needs no emphasis (Animashaun 2006). Goat happens to have leaner meat (intra-muscular and back fat), have a lower dressing percentage, and have higher muscle shear force values than sheep (Sen *et al.*, 2004). Consumption of goat is permissible for most religions groups (Muslims) that are not allowed to eat pork or those that are culturally not allowed to eat beef (Hindus). El-Waziry *et al.* (2011) reported that uncastrated animals have faster growth rate, with ability to utilize feed better than castrated males. Esgpip (2008) reported that mature bucks often become more violent towards humans, and castration of goats aided in eliminating male odour and improve their market value through production of good meat. Kebede *et al.* (2008) noted that castration also help in controlling hereditary defects and poor development, as both sexes by tradition are permitted to mingle as a group. This study was designed to investigate the effect of body weight and method of castration on the cold and hot carcass characteristics of Savanna Brown goats.

MATERIALS AND METHODS

Experimental site. The research was carried out at the Department of Animal Production Teaching and Research Farm of School of Agriculture and Agricultural Technology, Federal University of Technology Minna, Niger State, Nigeria. Minna is located in the Southern Guinea Savanna zone on latitude 9 º 31′ and 9 º 42′ North and Longitude 6 º 29′ and 6 º 41′ East. The annual rainfall ranges from 1,200 - 1,300 mm and temperature ranges from 38 º - 40 º C. The area is at an altitude of 1,475 m above sea level, and is characterized by two seasons, the wet season (April- October) and the dry season (November-March) (NSADP, 1995).

Experimental design. Twenty-four (24) male (bucks) of Savanna Brown goats were used and were divided into two groups based on body weight: 4-8 kg and 8-12 kg. There were 12 bucks in each weight categories. The animals were divided into six treatment groups on weight bases. Each treatment contained four animals with two replicates and two animals per replicate. Treatment 1, 2 and 3 were goats with weights between 4-8 kg and were divided based on their methods of castration into non-castrates, open castration (surgical) and close castration (burdizzo) respectively. Treatment 4, 5 and 6 consisted of bucks weighing between 8-12 kg, and were similarly grouped to open castration, close castration and non-castrates as in treatments 1, 2 and 3 respectively. The experimental design was completely randomized design with 3x2 factorial arrangement.

Management of the experimental animals. The animals were managed under semi-intensive system in a cross ventilated disinfected pens. The animals were vaccinated against Peste-des-petits Ruminante (PPR) virus. Each animal was housed in a separate pen and were also fed individually at 5 % body weight according to the procedure of Mamman *et al*. (2014). The animals were castrated two weeks after purchase. The goats were provided with feed and mineral salt licks. Endo- and ecto parasites were controlled by the use of deworming drugs such as Albendazole® which were administered orally at 5 ml per 10 kg body weight. The pens used were regularly cleaned and water were supplied *ad libitum*. Goats were fed with concentrate diet and cowpea husk basal diet. Concentrate was fed in the morning 08:0 a.m. – 09:00 a.m. before they were allowed to graze from 10:00 a.m. - 04:00 p.m. inside the research farm. Then, they were fed with the cowpea husk in the evening. The experiment lasted for fourteen (14) weeks and data were collected on feed intake, weight gain and carcass characteristics.

Data Analysis. Data collected were subjected to analysis of variance (ANOVA) using the SAS Package (2002) and significance determined at 5 % level of probability. The difference between the means were separated using the Duncan's multiple range test (1955).

RESULTS AND DISCUSSION

Table 1 shows the effects of methods of castration and weight at castration on hot carcass of Savanna Brown goat bucks. Close castrates differ significantly in slaughter weight and percentage of hot carcass compared to open and non-castrates. This is not in agreement with the work of Nsoso *et al.* (2004) who in their study on the influence of castration method and age on the percentage of dressing, reported that different methods of castration and age (14 months) does not significantly affect the dressing percentage, while at age of 22 months, Close (rubber ring and burdizzo) castration method significantly demonstrates higher dressing percentage compared to intact goats. Similarly, in this study, it was observed that in non-castrates, there were significant increase in weight of fore leg, hind leg, thoracic, rib and neck, while lumbar weight was significantly higher in open castrates. Effect of weight shows that goats weighing 4-8 kg were superior to those weighing between 8-12 kg in hot carcass percentage. However, those weighing 8-12 kg differs significantly from goats weighing between of 4-8 kg in slaughter weight, percentage of fore leg, hind leg, lumbar, rib and neck weight. This result conforms to the findings of Kashif *et al*. (2016) who reported that the class of animals significantly affected dressing percentage. They further revealed that castrates at the age of 6 months had better dressing percentage followed by intact male with castrates at the age of 4 months having least dressing percentage. Jones *et al*. (1984) also noted that the proportions of carcass weight and that of the non-carcass parts relative to empty body weight were affected by maturity or animal size and castration. The result of interaction effects between castration and weight revealed that castrates of both weight group achieved the highest values in hot carcass percentage. This result agrees with the findings of Rahaman *et al*. (2005) who noted that intact males had lower dressing percentage compared to castrates.

Table 2 shows the effects of methods of castration and weight at castration on cold carcass of Savanna Brown goats. In all the treatments, significant differences in chilling loss in the percentage of cold carcass, foreleg, hind leg, thoracic region, lumbar region, rib and neck were recorded. This might have been due to the effect of methods of castration. This is contrary to the report of Amorim *et al*. (2008) who in their findings reported that carcass has small subcutaneous fat in the finishing stage; these fat during carcass cooling can act as thermal insulator to reduce the loss of water from carcass surfaces. Husain *et al*. (2000) reported about 2.5 to 6.9 % loss of its weight from carcass of Capretto when cold storage was carried out for 24 hours.

CONCLUSION AND RECOMMENDATION

This study shows that castration by burdizzo (close) improved hot carcass and cold carcass characteristics significantly over open castration and non -castrates and that weight had significant effects on carcass as goats weighing 4-8 kg significantly ($p<0.05$) influenced hot and cold carcass weight over goats weighing 8-12 kg, under semi-intensive management. Close castration for goats weighing between 4-8 kg is recommended for improved hot and cold carcass performance.

Table 1:Main and interaction effects of method of castration and weight at castration on hot carcass of Savanna Brown bucks

Factor	slaughter weight (kg)	Hot Carcass (%)	Fore leg (%)	Hind leg (%)	Thoracic region (%)	Lumbar region (%)	Rib (%)	Neck (%)
Castration								
Non castrate	9.23^{b}	48.53^{b}	13.28^{a}	14.59^{a}	4.06^{a}	5.96^{b}	7.57^{a}	4.85^{a}
Close castrate	11.25^{a}	50.91^{a}	10.16^{c}	11.96^{c}	2.63^{b}	6.76^{b}	6.03^{b}	3.96^{b}
Open castrate	9.00^{b}	47.33^{c}	12.87^{b}	13.79^{b}	2.22^{c}	8.06^{a}	4.16^{c}	3.62^{c}
SEM	0.09	0.13	0.11	0.10	0.08	0.08	0.08	0.08
LS	*	*	*	*	*	*	*	*
Weight(kg)								
4-8	9.17^{b}	49.38^{a}	11.86^{b}	12.90^{b}	2.94	6.53^{b}	5.65^{b}	4.00^{b}
8-12	10.49^{a}	48.46^{b}	12.34^{a}	13.99^{a}	2.99	7.29^{a}	6.18^{a}	4.28^{a}
SEM	0.07	0.11	0.09	0.08	0.06	0.07	0.07	0.06
LS	*	*	*	*	NS	*	*	*
Interaction								
NC X W_1	9.00^{c}	49.73^{b}	13.37^{a}	14.44^{a}	4.44^{a}	6.67^{c}	7.78^{a}	4.40^{b}
NC X W_2	9.47^{b}	47.33^{c}	13.19^{a}	14.73^{a}	3.68^{b}	6.84^{c}	7.36^{b}	5.26^{a}
CC X W_1	9.50^{b}	51.05^{a}	10.00^{c}	11.23^{c}	2.17^{d}	5.77^{e}	4.74^{c}	3.38^{cd}
CC X W_2	13.00^{a}	50.76^{a}	10.31^{c}	12.69^{b}	3.08^{c}	6.15^{d}	7.31^{b}	4.23^{b}
OC X W_1	9.00^{c}	47.36^{c}	12.22^{b}	13.03^{b}	2.22^{d}	7.22^{b}	4.44^{c}	3.88^{c}
OC X W_2	9.00^{c}	47.30^{c}	13.53^{a}	14.56^{a}	2.22^{d}	8.89^{a}	3.88^{d}	3.36^{d}
SEM	0.12	0.11	0.12	0.12	0.11	0.12	0.12	0.11
LS	**	**	*	*	**	**	**	**

[a b c] Means in the same column with different superscripts were significantly ($P< 0.05$) different *=Significant level ($P=0.05$), N S = Not significant C x W=Interaction between castration and weight, W_1=4-8 kg goats, W_2 = 8-12 kg goats, NC= Non-castrates, CC= Close castrates, OC=Open castrate

Table 2:Main and interaction effects of method of castration and weight at castration on cold carcass of Savanna Brown bucks

Factor	Cold Carcass (%)	Fore leg (%)	Hind leg (%)	Thoracic region (%)	Lumbar region (%)	Rib (%)	Neck (%)	Chilling loss (%)
Castration								
Non castrate	46.95^{b}	10.80^{a}	11.35^{b}	2.45^{a}	5.70^{b}	6.50^{a}	3.50^{a}	4.45^{b}
Close castrate	47.91^{a}	8.30^{b}	9.87^{c}	1.80^{b}	4.55^{c}	5.46^{b}	2.25^{b}	4.51^{b}
Open castrate	44.70^{c}	10.55^{a}	11.70^{a}	1.65^{b}	6.93^{a}	3.61^{c}	2.30^{b}	5.18^{a}
SEM	0.08	0.08	0.09	0.08	0.08	0.09	0.08	0.08
LS	*	*	*	*	*	*	*	*
Weight(kg)								
4-8	46.69^{a}	9.83	10.77^{b}	2.53^{a}	6.03^{a}	4.93^{b}	2.77	4.40^{b}
8-12	46.11^{b}	9.93	11.18^{a}	1.40^{b}	5.42^{b}	5.44^{a}	2.60	5.14^{a}
SEM	0.07	0.07	0.07	0.07	0.06	0.07	0.07	0.67
LS	*	NS	*	*	*	*	NS	*
Interaction								
NC X W_1	48.30^{a}	11.10^{a}	12.20^{b}	3.30^{a}	6.10^{c}	6.67^{a}	3.30^{b}	3.33^{d}
NC X W_2	44.80^{c}	10.50^{b}	10.50^{c}	1.60^{c}	5.30^{d}	6.32^{a}	3.70^{a}	5.56^{a}
CC X W_1	47.36^{b}	8.40^{d}	9.50^{d}	2.10^{b}	5.30^{d}	4.24^{b}	2.60^{c}	4.44^{c}
CC X W_2	48.46^{a}	6.20^{d}	6.90^{c}	1.50^{c}	3.80^{e}	6.67^{a}	1.90^{e}	4.55^{c}
OC X W_1	44.40^{d}	10.00^{c}	10.60^{c}	2.20^{b}	6.70^{b}	3.88^{b}	2.40^{d}	5.44^{a}
OC X W_2	45.00^{c}	11.10^{a}	12.80^{a}	1.10^{d}	7.17^{a}	3.33^{c}	2.20^{e}	4.93^{b}
SEM	0.12	0.12	0.12	0.11	0.12	0.12	0.12	0.12
LS	**	**	**	*	**	**	*	**

$^{a\,b\,c}$ Means in the same column with different superscripts were significantly ($P< 0.05$) different *=Significant level ($P=0.05$), N S = Not significant C x W=Interaction between castration and weight, W_1=4-8 kg goats, W_2 = 8-12 kg goats, NC= Non- castrates, CC= Close castrates, OC=Open castrates

REFERENCES

Amorim, G. L., Batista, A. M. V., & Carvalho, F. F. (2008). Substituicao do milho por casca de soja: Consumo, rendimemtos e caracteristicas de carcaca e rendimento de buchada de caprinos. *Revista Acta Scientiarium Animal Sciences*, 30(1), 41- 49.

Animashaun, R. A. (2006). Haematological and biochemical indices of weaner rabbits fed concentrate and *Synderella nodiflora* forage supplement. *Proceedings of the 11th Annual Conference of the Animal Science Association of Nigeria (ASAN) Ibadan, Nigeria. pp. 29-31.*

El-Waziry, A. M., Al-Owaimer, A. N., Suliman, G. M., Hussein, E. S., & Abouheif, A. M. (2011). Performance, carcass characteristics and meat quality of intact and castrated Ardhi goat kids fed high energy diet. *Journal of Animal and Veterinary Advances*, 10(16), 2157-2162.

Duncan, D. B. (1955). Multiple Range and Multiple Test. *Biometrics*, 11:1 – 42.

Esgpip B. (2008). Ethiopia sheep and goat productivity improvement programme. *Technical Bulletin No.18, December 2008.*

HUSAIN, M H., MURRAY, P.J., and TAYLOR, D. G. (2000a). In '7th Int. Conf. on Goats' pp. 216-8, France.

Jones, S. D. M., Rompala, R. E., Wilton, J. W., & Watson, C. H. (1984). Empty body weights, carcass weights and offal proportions in bulls and steers of different mature size. *Canadian Journal of Animal Science*, 64, 53-57.

Kebede, T., Lemma, T., Dinka, H., Guru, M., & Sisay, A. (2008). Growth performance and carcass characteristics of ArsiBale goats castrated at different ages. *Journal of Cell Animal Biology*, 2(11), 187-194.

Kashif, I., Muhammad, Y., Muhammad, R. & Mubarak, A. (2016). Effectiveness of high input feeding system in relation to growth and carcass quality of various classes of Beetal kids. *Pakistan Journal of Agricultural Science*, 53(1), 277-282.

Mamman, M. O., Aka, L. O., Ahmed, A., Sa'idu, B., Abubakar, A. A., Adamu, U., Ibrahim, H. M., Garba, B., & Raji, A. A. (2014). Short term comparative analysis of serum electrolytes and performance characteristics of castrated and intact Red Sokoto bucks. *Tanzania Veterinary Journal*, 29(1), 7279

NSADP (1995). Niger State Agricultural Development Project: 30th Quarterly Report, January – March. *Nigeria Agro Newsletter*, 3(2), 32-33.

Nsoso, S. J., Mannathoko, G. G., Tadubana, T. T., & Malela, L. (2004). The effect of methods of castration on live weight, dressed percentage and linear body measurements on indigenous Tswana goats raised under semi-intensive management in Southeast Botswana. *Livestock Research for Rural Development*, 16(2), 625-629.

Rahaman, M. T., Khan, M. Z. I., Karim, M. R., & Haque, Z. (2005). Cross morphometrical and analysis of muscles of different body regions of adult wether castrated Black Bengal goats and its cascass characteristics. *Bangladesh Journal of Veterinary Medicine*, 3(2), 144-147.

SAS (2002). Statistical Analysis System. Institute Inc., Cary, NC, USA.

Sen, A. R., Santra, A., & Karim, S. A. (2004). Carcass yield, composition and meat quality attributes of sheep and goat under semi-arid condition. *Meat Science Journal*, 66(4), 757-763.

49 INFLUENCE OF CLIMATE EXTREMES ON LIVESTOCKS' DISEASES OCCURRENCE IN BURKINA FASO

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Abstract

West African Sahel constitutes one of the most vulnerable region to climate change and variability which is adversely impacting mankind and its environment. An effective climate change adaptation and mitigation strategies within the Sahel regions, need a good understanding of past climate evolutions and related impacts. This study examines the impacts of climate extremes on the occurrence of ten livestock diseases of economic and public heath importance. These impacts were checked using Pearson's correlation test and multiple linear regression analysis. The results showed significant association between livestock diseases and climate extremes that explained between 23.2 to 50.2 % of the variations in livestock diseases occurrence. In the Sudan-Sahel and Sahel zones, nights and days warming, longer wet spells and dry spells could have favoured the occurrence of Pasteurellosis of small ruminants, Lumpy skin disease and Newcastle disease. Inversely, in the Sudan zone, the decrease in daily temperature range, in nights and days cooling seems to have reduced the occurence of the Symptomatic anthrax and Swine pasteurollosis respectively. Nevertheless, in the zone, longer wet spells and nights cooling could have exacerbated the resurgence of Foot-and-mouth disease. To address the adverse effects of climate change on livestock productions, climate-smart policy promoting drought-tolerant breeds, that can adapt extreme climate conditions, is recommended. Above all, the adoption of practice such as crop-livestock integration is encouraged in order to mitigate the adverse effects of both climate change and non-climatic factors on pastoral sector in Burkina Faso.

Key words: Climate change; Livestock diseases; Food security; West African Sahel.

50 MEAT YIELD AND CARCASS CHARACTERISTICS OF BROILER CHICKENS FED *MORINGA OLEIFERA* LEAVE POWDER AS ALTERNATIVE TO SYNTHETIC LYSINE

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Abstract

The research evaluated the meat yield and carcass characteristics of broilers fed Moringa oleifera leave powder (MOLP) as alternative to synthetic lysine (SL). A total of 250 pieces day-old broiler chicks of Cobb-500 breed were used under a completely randomised design (CRD). The chicks were divided into five (5) treatment groups, T1(100%SL, 0%MOLP), T2 (75%SL, 25%MOLP), T3 (50%SL, 50%MOLP), T4 (25%SL, 75% MOLP) and T5 (0%SL, 100%MOLP). Water was provided ad libitum. Data on carcass characteristics was collected on primal cuts (Breast, Thigh, Drumstick, Wings, Back, Head, Neck, Shank,) and visceral organs (Liver, Heart, Gizzard, Abdominal Fat, Intestine, Proventriculus, Spleen, Lungs, Crop). There were no Significant differences (P>0.05) in primal cuts and visceral organs except for Shank which significantly differ (P<0.05) with T4 having the highest value of 4.63% and T1 having the lowest value of 3.41%. T3 significantly differed (P<0.05) in the heart amongst the treatment group with the highest value of 0.45% as against the lowest value of 0.22% from T4.Moringa oleifera Leave Powder (MOLP) can serve as an adequate alternative to synthetic lysine as it has no deleterious effect on the carcass yield and carcass characteristics of broiler chickens.

Keywords: Moringa oleifera Leave Powder, Synthetic Lysine, Broiler Chicken, Meat Yield, Carass

Description of Problem

The consumption of synthetic food and synthetic food materials have been identified to cause health challenges in animals and a consequent negative effect on man as a result of the inherent residues consumed from the products of such animals (meat/milk) as food. This necessitated the recent call by scientists on consumers to reduce or move from synthetic food substances to organic food materials. Fanatico *et al.* (2013) reported that in organic livestock production, synthetic amino acids are largely banned. Methionine is the only synthetic amino acid still permitted under the USDA National Organic Program (NOP) but only with restrictions. The prohibition of animal protein sources in poultry nutrition in many countries, and also the relatively high costs of these products, demand new alternatives. The possible alternative in this situation is the use of plant protein (Beski *et al*., 2015).

Chicken is a significant source of protein in human diets, and it is held in high esteem in many culinary traditions. Its nutrient-dense composition makes it an important part of a nutritious diet. Chicken meat is famous amongst health-conscious people for its low saturated fatty acid (SFA) and high polyunsaturated fatty acid (PUFA) composition (Vilarrasa *et al.,* 2015).

Recently, the cost of table size chicken has significantlyrisen due to high price of feed This has consequently affected the size and supply of chicken in the market (Kurmanath, 2006). The economic viability of poultry production is dependent upon sourcing high quality feed ingredients, having knowledge of their amino acid composition, and formulating a diet that supports the birds' maintenance and productive functions.

Amino acids are the building blocks of protein and function in the build-up, maintenance and replacement of body tissues, muscles, organs and some of the body hormones. The essential amino acids are those the body cannot synthesise in sufficient quantity to satisfy the nutritional requirements for good health. Hence, the need to supplement them. The nine essential amino acids are histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine.

Moringa oleifera is very useful as a feed supplement for animals, as its leaves are highly nutritious. The leaves of *Moringa oleifera* are the most nutritious part, being a significant source of vitamin B complex, vitamin C, pro-vitamin A as beta-carotene, vitamin K, manganese, and protein among other essential nutrients (Leone *et al.*, 2015). *Moringa oleifera* can be used as a source of micronutrients and as a dietary supplement in poultry (Mahajan *et al.*, 2019). *Moringa oleifera* was reported to be an excellent source of vitamins and amino acids that reportedly boost immune systems (Olugbemi *et al.*, 2010). The research evaluated the meat yield and carcass characteristics of broiler chickens administered with *Moringa Oleifera* leave powder as an alternative to synthetic lysine.

Materials and methods

Location of the experiment

The experiment was conducted at the Teaching and Research Farm of Federal University of Technology Minna, Gidan-Kwano, Bosso Local Government Area of Niger State. The area falls within the Southern Guinea Savannah zone of Nigeria with mean annual rainfall of between 1100-1600 mm and a mean temperature of between 21 ^{0}C and 36.5 ^{0}C (Usman, 2011).

Source of experimental materials and preparation of Moringa oleifera leaves Powder (MOLP)

A total of 250pieces day-old broiler chicks of Cobb-500 breed were used in the research. The chicks were purchased from Olam Farms, Kaduna, Nigeria. The Moringa leaves was sourced from Kpandaji village, in Paikoro L.G.A of Niger State, dried under room temperature and grounded to powder using the conventional grinding machine. The Newcastle Disease Vaccine (Lasota) and Infectious Bursal Disease Vaccine (Gumboro) were purchased at the Niger State Veterinary Clinic Bosso, Minna, Niger State

Experimental design

A completely randomised design (CRD) was used. The chicks were managed under a deep litter system and divided into five (5) treatment groups, T1, T2, T3, T4 and T5. Group T1 denotes chickens administered 100% (250.00g) synthetic lysine and 0% (0.00g) MOLP lysine source, Group T2 denotes chickens administered 75% (187.50g) synthetic lysine and 25% (62.50g) MOLP lysine source, Group T3denotes chickens administered 50% (125.00g) synthetic lysine and 50% (125.00g) MOLP lysine source, Group T4denoteschickens administered 25% (62.50g) synthetic lysine and 75% (187.50g) MOLP lysine source, and Group T5 denotes chickens administered 0% (0.00g) synthetic lysine and 100% (250.00g) MOLP lysine source. Each group has five replicates and each replicate was randomly allotted ten (10) chicks. Newcastle disease vaccine was administered at day eight (8) and day twenty-two (22), while the Infectious bursal disease vaccine was administered at days fifteen (15) and twenty-nine (29) of the research, respectively. The birds were orally vaccinated through drinking water following the recommendation of Cargill *et al.* (2007).

Experimental diets

Experimental Starter and Finisher diets were formulated as shown in tables 1& 2 below to cater for the nutritional requirements of the birds. The birds were fed adequately and provided with drinking water *ad libitum*.

Parameters Measured

Meat yield and carcass characteristics

At the end of the experiment, two chickens from each replicate were randomly selected for meat yield and carcass characteristics analysis. The selected chickens were starved of feed and water overnight after which their individual life weight was taken. They were then slaughtered by cutting the jugular vein and scalded in warm water for thirty (30) seconds and the feathers manually removed. Thereafter, the record of the fully dressed individual carcass weight was taken.

The carcasses were separated into primal cuts (Breast, Thigh, Drumstick, Wings, Back, Head, Neck, Shank,) and visceral organs (Liver, Heart, Gizzard, Abdominal Fat, Intestine, Proventriculus, Spleen, Lungs, and Crop). The weight of each body cut, and organ was taken and expressed as percentage of the life weight of each carcass. The dressing percentage and percentage of body weight in relation to the live weights of the chickens were calculated as described by Aduku and Olukosi (1990) in the formulae as follow.

$$Dressingpercentage = Dressedcarcassweight/Liveweight \times \frac{100}{1}$$

$$Percentageofbodycut = Weightofbodycut/Liveweight \times 100/1$$

Data analysis

Data obtained were subjected to Analysis of Variance (ANOVA) using Statistical Package for Social Science(SPSS) IBM Version 22. Means were separated using Least Significant Difference (LSD).

Table 1: Experimental Starter diets of Broiler Chickens Administered with *Moringa oleifera* Leaf Powder as an Alternative to Synthetic Lysine

Ingredients (kg)	T1	T2	T3	T4	T5
Maize	50.57	50.38	49.48	47.87	46.97
Maize Offal	11.00	11.00	11.00	11.00	11.00
Groundnut Cake	32.43	30.95	30.17	30.11	29.34
Fish meal	3.00	3.00	3.00	3.00	3.00
Bone meal	2.00	2.00	2.00	2.00	2.00
Salt	0.25	0.25	0.25	0.25	0.25
Vitamin Premix	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.19	0.13	0.06	0.00
MOLP	0.00	1.74	3.47	5.21	6.94
Methionine	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00
Calculated Analyses					
Crude Protein%	23.00	23.00	23.00	23.00	23.00
MetabolizableEnergy (Kcal/kg)	2855.62	2860.50	2857.71	2847.73	2845.06

SL: Synthetic Lysine, MOLP: Moringa oleifera Leave Powder, T1: (100%SL, 0%MOLP), T2: (75%SL, 25%MOLP), T3: (50%SL, 50%MOLP), T4: (25%SL, 75% MOLP) and T5: (0%SL, 100%MOLP)

Table 2: Experimental Finisher diets of Broiler Chickens Administered with *Moringa oleifera* Leaf Powder as an Alternative to Synthetic Lysine

Ingredients (kg)	T1	T2	T3	T4	T5
Maize	64.27	64.08	63.16	61.57	60.67
Maize Offal	5.00	5.00	5.00	5.00	5.00
Groundnut Cake	24.73	23.25	22.49	22.41	21.64
Fish meal	3.00	3.00	3.00	3.00	3.00
Bone meal	2.00	2.00	2.00	2.00	2.00
Salt	0.25	0.25	0.25	0.25	0.25
Vitamin Premix	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.19	0.13	0.06	0.00
MOLP	0.00	1.74	3.47	5.21	6.94
Methionine	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00
Calculated Analyses					
Crude Protein%	20.00	20.00	20.00	20.00	20.00
Metabolizable Energy (Kcal/kg)	3009.56	3014.44	3011.44	3001.67	2999.00

SL: Synthetic Lysine, MOLP: Moringa oleifera Leave Powder, T1: (100%SL, 0%MOLP),
T2: (75%SL, 25%MOLP), T3: (50%SL, 50%MOLP), T4: (25%SL, 75% MOLP) and T5: (0%SL, 100%MOLP)

Results and discussion

Proximate composition of experimental diets

Table 3 and 4 shows the proximate composition of the starter and finisher feeds respectively. The crude proteins from both feeds are within the required range as reported by Aduku (2005). Similarly, the ash and fat contents are within the range reported by Obioha (1992).

Table 3 Proximate composition of starter diets of broiler chickens administered with *Moringa oleifera*leavespowder (MOLP) as an alternative to synthetic lysine

Parameter	T1	T2	T3	T4	T5
Moisture Content (%)	10.00	8.60	8.40	6.00	10.14
ASH (%)	7.84	6.38	7.24	8.11	7.18
FAT (%)	6.38	7.24	7.81	7.46	6.98
Crude Protein (%)	23.45	24.15	23.80	23.28	22.60
Crude Fibre (%)	3.50	2.00	3.00	2.00	2.00
Nitrogen Free Extract (%)	48.83	50.95	49.75	53.15	50.60

SL: Synthetic Lysine, MOLP: Moringa oleifera Leave Powder, T1: (100%SL, 0%MOLP), T2: (75%SL, 25%MOLP), T3: (50%SL, 50%MOLP), T4: (25%SL, 75% MOLP) and T5: (0%SL, 100%MOLP)

Table 4 Proximate composition of finisher diets of broiler chickens administered with *Moringa oleifera* leaves powder (MOLP) as an alternative to synthetic lysine

Parameter	T1	T2	T3	T4	T5
Moisture Content (%)	6.99	6.60	6.40	7.30	7.14
ASH (%)	4.20	4.50	5.24	4.11	4.18
FAT (%)	11.60	11.24	10.81	10.46	10.98
Crude Protein (%)	20.67	20.15	20.80	20.28	20.60
Crude Fibre (%)	4.65	4.56	4.87	5.00	4.95
Nitrogen Free Extract (%)	51.89	52.95	51.88	52.85	52.33

SL: Synthetic Lysine, MOLP: Moringa oleifera Leave Powder, T1: (100%SL, 0%MOLP), T2: (75%SL, 25%MOLP), T3: (50%SL, 50%MOLP), T4: (25%SL, 75% MOLP) and T5: (0%SL, 100%MOLP)

Table 5Meat yield and carcass characteristics of broiler chickens administered with *Moringa oleifera* leaf powder (MOLP) as an alternative to synthetic lysine

Parameter	T1	T2	T3	T4	T5	SEM
Live Weight (g)	1962.00	1857.00	1782.33	1935.67	1825.33	36.90
Slaughter Weight (g)	1898.33	1792.33	1715.00	1873.67	1764.00	37.59
Plucked Weight (g)	1792.00	1700.00	1622.33	1785.00	1669.33	35.35
Dressed Weight (g)	1481.00	1445.00	1391.67	1486.67	1450.33	34.14
Dressing (%)	75.16	77.80	78.09	76.74	79.41	0.73
Cut-up parts						
Breast (%)	17.87	17.83	18.56	17.72	19.25	0.45
Thigh (%)	12.71	12.86	12.90	12.77	13.64	0.23
Drumstick (%)	8.79	10.13	9.64	9.39	9.94	0.22
Wings (%)	10.55	10.26	10.27	10.22	10.60	0.16
Back (%)	12.25	11.91	12.13	11.44	11.65	0.18
Head (%)	2.41	3.02	2.64	2.73	2.55	0.10
Neck (%)	5.23	5.59	5.01	5.30	5.71	0.12
Shank (%)	3.41^{b}	4.56^{a}	3.84^{ab}	4.63^{a}	4.22^{ab}	0.17
Visceral organs						
Liver (%)	1.74	1.79	1.85	1.54	1.51	0.09
Heart (%)	0.28^{ab}	0.36^{ab}	0.45^{a}	0.22^{b}	0.33^{ab}	0.03
Gizzard (%)	1.52	1.78	1.63	1.92	1.46	0.08
Abdominal Fat (%)	1.81	1.20	0.71	1.08	0.90	0.22
Intestinal length (cm)	234.67	216.33	238.33	200.33	192.00	7.43
Filled Intestinal Weight (%)	6.90	4.96	5.65	5.06	4.76	0.34
Empty Intestinal Weight (%)	3.03	2.99	3.12	2.38	2.91	0.11
Proventriculus (%)	0.47	0.43	0.34	0.52	0.46	0.05
Spleen (%)	0.15	0.14	0.11	0.15	0.15	0.01
Lungs (%)	0.32	0.32	0.36	0.45	0.42	0.03
Crop (%)	0.36	0.41	0.34	0.71	0.27	0.08

a,b = means in the same row with different superscripts are significantly different ($p<0.05$)
SL: Synthetic Lysine, MOLP: Moringa oleifera Leave Powder, T1: (100%SL, 0%MOLP), T2: (75%SL, 25%MOLP), T3: (50%SL, 50%MOLP), T4: (25%SL, 75% MOLP) and T5: (0%SL, 100%MOLP)

The result of Carcass characteristics indicates no significant differences (P>0.05) in most of the parameters measured except for shank and heart. The percentages of the shank weight were significantly higher (P<0.05)in T4(4.63%)than those fed T1 but similar to those fed other test diets. The result indicated the diets promoted both shank and heart weights percent. The values for shank and heart weights in this study ranged from 3.41 – 4.63% and 0.22 – 0.45% respectively along the treatment rows. These findings show higher values than those reported by Igwebuike et al., (2017) in their research on the Growth Performance and Carcass Characteristics of Broiler Chickens Fed *Moringa oleifera* and Baobab (*Adansonia digitata*) Leaf Powders as Replacement for Synthetic Premix in North-East Nigeria.

Conclusion

Moringa oleifera Leave Powder (MOLP) can serve as an adequate alternative to synthetic lysine as it has no deleterious effect on the carcass yield of broiler chickens.

References

Aduku, A.O. & Olukosi, J.O. (1990). *Rabbit management in the tropics*. Abuja, Nigeria: Living Book Series G.U. Publications.

Aduku, A.O. (2005) Tropical Feed Stuff Analysis Table. Department of AnimalScience, Ahmadu Bello University, Zaria

Beski. S.M., Robert A. S., & Paul A. I. (2015). Specialized protein products in broiler chicken nutrition: A review. *Journal of Animal Nutrition* (1) 47-53

Cargill, P.W., Joey, J., & Merial Avian Business Unit UK. (2007). Vaccine Administration to Poultry Flocks. Retrieved(http://www.thepoultrysite.com/articles/742/vaccine-administration- to-poultry-flocks/)

Fanatico, A.C., Brewer, V.B., Owens-Hanning, C.M., Donoghue, D.J., & Donoghue, A.M. (2013). Free-choice feeding of free-range meat chickens.*Journal of Applied Poultry Research*. 22 :750–758. http://dx.doi.org/ 10.3382/japr.2012-00687.

Igwebuike JU, Medugu CI, Kwari ID, Augustine C, Peter J, Bashir IM. 2017. Growth Performance, Nutrient Digestibility and Carcass Characteristics of Broiler Chickens Fed Moringa (*Moringa oleifera*) and Baobab (*Adansonia digitata*) Leaf Powders to Replace Synthetic Premix in North-East – Nigeria.*Journal of Scientific and Engineering Research*, 4(12): 10-16.

Kurmanath, K.V. (2006). Influence of High Price of Feed on the Supply of Chicken in the Market. (http://www.poultry.production.com date 6/2/2012, 4:30am.

Leone, A.; Spada, A.; Battezzati, A.; Schiraldi, A.; Aristil, J.; Bertoli, S. (2015) Cultivation, genetic, ethnopharmacology, phytochemistry and pharmacology of Moringa oleifera leaves: An overview. Int. J. Mol. Sci. 2015, 16, 12791–12835.

Mahajan SG, Mali RG, Mehta AA. Effect of Moringa oleifera Lam. seed extract on toluene disocyanate-induced immune-mediated inflammatory responses in rats. J Immunotoxicol. 2007 Apr;4(2):85-96. doi: 10.1080/15476910701337472. PMID: 18958717.

Olugbemi, T.S.; Mutayoba, S.K.; Lekule, F.P. Effect of Moringa (Moringa oleifera) inclusion in cassava based diets fed to broiler chickens. Int. J. Poult. Sci. 2010, 9, 363–367.

Usman, H.I. (2011). Effects of time of intercropping soy bean on weed suppression and performance of upland rice in southern guinea savanna of Nigeria. *PhD. Thesis, Department of Crop Production, Federal University of Technology Minna. Pp24.*

Vilarrasa,E., Guardiola,F., Codony,R., Esteve-Garcia,E. & Barroeta,A. (2015). Use of combinations of re-esterified oils, differing in their degree of saturation, in broiler chicken diets. *Poultry Science*,94,1539-1548.

51 SEMEN CHARACTERISTICS OF RABBIT BUCKS FED GRADED LEVELS OF *Newbouldia laevis* LEAF MEAL

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Abstract
This study evaluated the effect of Newbouldia laevis leaf meal on the semen characteristics of Rabbit bucks. Twenty four rabbit bucks of 5-6 months old weighing 1.44 kg – 1.96 kg were acclimatized and allotted randomly into four treatments: T1 (control), T2, T3 and T4. The crude protein was set at 16% with inclusion levels of 0 %, 2.5 %, 5 % and 7.5 % Newbouldia laevis leaf meal respectively for12 weeks. Semen samples were collected and evaluated fortnightly for semen volume, semen motility and semen concentration. The mean values of semen volume and semen motility of rabbit bucks was not significantly (p>0.05) different across all the groups. The mean values for semen concentration of T4 was significantly (p<0.05) different from the controls. It was concluded that Newbouldia laevis leaf meal improved the testicular functions of rabbit bucks.

Key words: Semen characteristics, Rabbit bucks, *Newbouldia laevis* leaf meal.

INTRODUCTION

The utilization of herbal medicine has gradually acquired essential therapeutic role in replacing the artificial drugs for animals and humans owing to increased occurrence of their resistance to synthetic drugs (Olowosulu and Ibrahim, 2006). In Africa, especially Nigeria, numerous plants had been acknowledged to possess therapeutic and dietary importance (Egba *et al*., 2014). In folk and conventional medicines, some herbal plants along with their extracts had been used to cure infertility in animals in their unaltered form (Vasudera and Sharma, 2007; Singh and Makkar, 2009). Many of these plants and their extracts had been documented to enhance libido, sexual behavior, mating and sperm production (Tomova *et al.,* 1981; Chauhan *et al.*, 2007), at the same time other plants balanced the level of hormone in hypothalamic-pituitary gonadal axis (Gamache and Acworth, 1998; Asuquo *et al.*, 2013) like testosterone hormone in male and follicle stimulating hormone in both male and female (Koumanov *et al.*, 1982). *Newbouldia laevis* is one of the plant species widely used in folk medicine which its therapeutics standards stood the trial of the period. Sustaining the contribution of rabbit to the already deficient per capita animal protein intake also requires ensuring increase productivity, which can be guaranteed by the use of breeding bucks with proven fertility status. Globally, drugs and synthetic hormones worldwide have been the main stay for boosting animal's fertility and controlling reproductive related diseases in livestock with attendant side effects both on the animals and consumers as well. However, with little or less information on the reproductive potential of *Newbouldia laevis* in animals particularly rabbits. This study therefore, was conducted with improved semen characteristics of rabbit bucks fed graded levels of *Newbouldia laevis* leaf meal.

MATERIALS AND METHODS

Location of the experiment

The study was carried out at the Teaching and Research Farm, of the Department of Animal Production, School of Agriculture and Agricultural Technology, Federal University of Technology Minna, Gidan Kwano campus, Niger State. The location lies geographically in the North central of Nigeria within the latitude of 9˚31'18.2'' North and longitude 9˚27'40'' East with elevation ranging from 230-250m. It has an average annual rainfall between 1338 mm and 300^{c} mean ambient Temperature (FUTMIN, 2012).

Experimental Animals and Plant samples

Twenty-four (24) apparently healthy, domestic rabbit bucks (*Oryctolagus cuniculus*) of 5.0 ± 6.0 months old of mean body weight of 1.44 – 1.96 kg used for the study were obtained from Zaria, Kaduna State, Nigeria. The rabbit bucks were screened and treated with broad spectrum medication (ivomectin, sulphadimidine and penicillin-streptomycin) against endoparasites, helminthes and other micro-organism prior to the inception of the experiment. The bucks were housed in rabbit cages, one buck per cage. Feed and water were given *ad libitum*. *Newbouldia laevis* leave were obtained from Alapa, Kwara state and Ukpo, Anambra State, Nigeria. The fresh leaves were air dried under shade, grinded, weighed and added to the feed raw materials, ground together to form the experimental diets.

Experimental Design and Diets.

The rabbit bucks were complete randomly designed and selected into four treatments of six rabbit each, designated as group T1, T2, T3 and T4. All bucks were fed diets of isonitrogenous and isocaloric values, consisting of maize, groundnut cake, rice offal's, *Newbouldia laevis*, vitamin premix, palm oil, bone meal, methionine and salt, as indicated in Table 1. The diets consisted of 0, 2.5 %, 5.0 % and 7.5 % of *Newbouldia laevis* leaf meal, respectively fed over a period of 12 weeks. In the course of feeding, semen samples were collected fortnightly for evaluation.

Semen collection

Semen samples were collected using a specially designed artificial vagina (AV) for rabbits consisting of a short plastic cylinder, latex condom used as a liner, whose end was cut off to allow both ends opened. A rubber band was used to fix the line on the cylinder at one end, then glycerol was administered into the space between the cylinder and the rubber liner and the other end of the cylinder was fixed with another rubber band to assemble the AV. The assembled AV was placed in a beaker of warm water at 40˚C, the warm water caused expansion of the glycerol within the liner and also provided the necessary pressure and temperature. Trace of water was cleaned from the AV, a short test tube was attached at one end of the AV and the other end lubricated with non-perfumed petroleum jelly for easy penetration. To collect the semen from the bucks, it was ensured that the collector was properly gloved and a rabbit doe was introduced to the buck's cage to serve as a teaser. The buck was watched closely and as it mounted the doe, the AV was placed gently at the vulva of the doe, so as to direct the penis into the AV for penetration and eventual ejaculation.

Table1. Gross composition of experimental diet

Ingredients	T1	T2	T3	T4
Maize	36.25	34.89	34.13	33.36
GNC	22.00	22.50	22.93	23.37
Maize offal	15.00	15.00	15.00	15.00
Rice bran	20.50	18.86	16.69	14.52
Palm oil	1.00	1.00	1.00	1.00
NBLM	0.00	2.50	5.00	5.00
Bone meal	4.00	4.00	4.00	4.00
Lysine	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25
Vit. Premix	0.50	0.50	0.50	0.50
Total	100	100	100	100
Calculated values				
Crude protein	16.00	16.00	15.99	16.00
Energy (Kcal/MEKg)	2544.23	2489.40	2437.27	2403.41
Fibre	11.59	11.39	11.00	11.01

KEY:-T1: (control diet), T2: (2.5 % Inclusion of *Newbouldia laevis* leaf meal), T3: (5 % Inclusion of *Newbouldia laevis* leaf meal), T4: (7.5 % Inclusion of *Newbouldia laevis* leaf meal), GNC (Groundnut Cake), NBLM (*Newbouldia laevis* leaf meal).

Data Collection

Data were collected from the ejaculate for semen evaluation according to the method described by Zemjanis, (1970). This involved the visual or gross evaluation of the semen immediately after semen collection. Volume of semen was measured directly from the calibrated tube used for the collection. The three colour categories of milky, creamy and watery designated 1, 2 and 3 were used for scoring colour as described by Zemjanis, (1970). Semen pH was determined by dipping a litmus paper into the ejaculate and corresponding colour changes were observed and recorded. Gross motility was examined as quickly as possible after collection, by putting a droplet of the semen sample on a pre-warmed glass slide, coverslip and examined at ×10 magnification while spermatozoa concentration was determined using haemocytometer. Micropipette was used to aspirate 0.1ml of semen and diluted with 1ml of water. The exterior of the pipette was wiped to remove any adhering semen. Two drops of diluted semen were allowed and the third one was drop on the haemocytometer then a slip is used to cover it. The haemocytometer was then examined using a light microscope at ×40 magnification and the sperm cells were counted in five Thomas squares of the chamber (i.e. four corner and the centre squares).

RESULTS

Proximate composition of *Newbouldia laevis* leaf meal.

The proximate composition of the *Newbouldia laevis* leaf meal is hereby presented in Table 2. The proximate composition shows dry matter of 89.40 %, crude protein of 29.75 %, crude fibre of 8.50 %, ash of 11.50 %, ether extract of 9.00 % and NFE of 41.25 %.

Table 2: Proximate composition of *Newbouldia laevis* leaf meal.

Parameter	Proximate composition (%)
Dry matter	89.40
Crude protein	29.75
Crude fibre	8.50
Ash	11.50
Ether extract	9.00
Nitrogen free extract (NFE)	41.25

Proximate composition of the experimental diets.

The proximate analysis of the experimental diets is hereby presented in Table 3. The crude protein of the diet ranges between 15.48 - 15.60 in T1 and (T2 and T3) respectively. The crude fibre of the diets was between 15.00 - 12.00 from T3 and T1 respectively.

Table 3: Proximate composition of the experimental diets

Parameter (%)	Treatments			
	T1	T2	T3	T4
Dry matter	91.40	93.80	94.20	92.20
Crude protein	15.48	15.60	15.60	15.00
Crude fiber	12.00	14.00	15.00	14.50
Ether extract	4.00	4.50	5.50	3.50
Ash	5.00	6.50	5.00	6.50
Nitrogen free extract	54.92	53.20	53.30	53.30

KEY:-T1: (control diet), T2: (2.5 % Inclusion of *Newbouldia laevis* leaf meal), T3: (5 % Inclusion of *Newbouldia laevis* leaf meal), T4: (7.5 % Inclusion of *Newbouldia laevis* leaf meal).

Semen characteristics of rabbit bucks fed graded levels of *Newbouldia laevis* leaf meal diets.

Semen characteristics of rabbit bucks fed graded levels of *Newbouldia laevis* leaf meal diets is shown in Table 4. The results showed the mean values of volume, gross motility and concentration of the semen of rabbit bucks fed with diets of 0, 2.50, 5.00 and 7.50% graded levels of *Newbouldia laevis* leaf meal. The mean volume of the rabbit bucks showed no significant difference (p>0.05) throughout the time of the experiment across all the groups but an increased ejaculate was observed between T1 (0.61±0.01), T2 (0.63±0.01), T3 (0.66±0.02) and T4 (0.69±0.05) as the inclusion level of *Newbouldia laevis* leaf meal increases. There was no significant (p>0.05) difference in gross motility amongst all the group of the experimental animal. Similarly, to the semen volume, there was concomitant increase in the mean gross spermatozoa motility as the level of inclusion of *Newbouldia laevis* leaf meal increased. However, the semen concentration of rabbit bucks showed a significant difference (p<0.05) while the semen colour and semen pH showed no significant (p>0.05) among treatment groups.

Table 4: Semen characteristics of rabbit bucks fed graded levels of Newbouldia laevis leaf meal.

Parameter (%)	Treatments					
	T1	T2	T3	T4	SEM	LS
Volume(ml)	0.61±0.01	0.63±0.01	0.66±0.02	0.69±0.05	0.02	NS
Motility (%)	63.01±1.16	63.40±1.42	66.73±2.30	69.14±4.02	1.28	NS
Concentration ($x10^6$/ml)	86.60 ± 7.06^c	137.48 ± 3.50^b	137.72 ± 3.42^b	152.25 ± 2.66^a	3.66	*
Colour	1.07	0.80	1.00	1.07	0.06	NS
pH	6.72	7.02	6.92	6.66	0.07	NS

a,b,c Means along the same row with the same superscript are not significantly (p<0.05) different, SEM- Standard error of mean , LS- level of significance, * -significant difference, T1: (control diet), T2: (2.5 % Inclusion of *Newbouldia laevis* leaf meal), T3: (5 % Inclusion of *Newbouldia laevis* leaf meal), T4: (7.5 % Inclusion of *Newbouldia laevis* leaf meal).

DISCUSSION

The mean semen volume values for all the groups were not significantly different (P>0.05), although, there was a progressive increase in semen volume across the treatment groups. The increase in volume may be due to some phytochemical constituents (flavonoids and steroidal saponin) contained in the plant (Morakinyo *et al*., 2008). This outcome observed was similar to an increase in sperm functions (semen volume inclusive) in rats treated with extract of *Kigellia africana* (which belongs to the family *Bignoniaceae* as *Newbouldia laevis*) (Azu *et al*., 2010). Similarly, the mean semen motility values were not significantly (P>0.05) different across all the treatment groups, though they were higher than the control values. This could as well be due to flavonoids and saponin phytochemical components of the *Newbouldia laevis* leaf meal. This agrees with Robak and Gryglewski (1988) and Morakinyo *et al.,* (2008) who reported that phytochemical constituents in *Newbouldia laevis* leaf possess fertility enhancing activities and stimulatory effect on androgen production which might contribute to increased testosterone level consequently resulting in increased semen motility, thus leading to improvement of spermatogenesis and fertility. Mean semen concentration values were rather significantly higher across the treatment groups compared to the control group. This may be due to the effect of some phytochemical constituents contained in the *Newbouldia laevis* leaf meal (flavonoid and saponin), which have been reported to be abundant in the plant especially flavonoids (which is an effective aromatase inhibitor) in the plant as reported by Azu *et al.,* (2010). The cytochrome P-450 aromatase is required for the conversion of androgen to estrogens and hence aromatase inhibitor would decrease the contraction of estrogen and maintain a higher level of testosterone, (Morakinyo *et al.,* 2008 and Azu *et al.,* 2010) which in turn increases semen concentration, improves spermatogenesis and fertility of the rabbit bucks.

CONCLUSION

From the findings of this work, it can be concluded that semen concentration values were increased significantly ($p<0.05$) in the *Newbouldia laevis* leaf diet treated groups (T2 = 137.48±3.50 $\times 10^6$/mL, T3 = 137.72± 3.42 $\times 10^6$/mL and T4 = 152.25±2.66 $\times 10^6$/mL), which may be responsible for its use as a fertility enhancer by the natives.

More so, 7.5% inclusion level of *Newbouldia laevis* leaves showed higher testicular functions (T4 bucks had better sperm motility (69.14±4.02%) and sperm volume (0.69±0.05mL) than T3 = (66.73±2.30%) and (0.66.±0.02mL), T2 (63.40±1.42%) and (0.63±0.01mL) and T1 that had (63.01±1.16 %) and (0.61±0.01mL)) respectively.

Based on the results obtained it is recommended that inclusion of *Newbouldia laevis* at 7.5 % improved the sperm concentration of rabbit bucks and should be considered in their feed formulation especially for breeders.

References

Asuquo, O.R, Oko, O.O., Brownson, E.S., Umoetuk, G.B., Utin, I.S. (2013). Effects of ethanolic leaf extract of *Spondias mombin* on the pituitary gonadal axis of female Wistar rats. Asian *Pacific Journal of Reproduction, 2(3):169-173.*

Azu, O.O., Duru, F.I.O., Osinubi, A.A., Oremosu, A.A., Noronha, C.C., Elesha, S.O., Okanlawon, A.O. (2010). Histomorphometric effects of *Kigelia africana* (Bignoniaceae) fruit extract on the testis following short-term treatment with Cisplatinin male Sprague–Dawley rats. *Middle East Fertility Society Journal, 15: 200-208.*

Chauhan, N.S., Rao,C.V., Dixit, V.K., (2007). Effect of Curculigoor chioides rhizomes on sexual behavior of male rats. *Fitoterapia, 78:530-534.*

Egba, S. I., Sunday, G. I. and Anaduaka, E. G. (2014). International organization of scientific research. *Journal of Pharmacy and Biological Science, 9 (3): 61-64.*

Gamache, P.H. and Acworth, I.N. (1998). Analysis of phytoestrogens and polyphenols in plasma, tissue and urine using HPLC with coulometric array detection. *Proceedings of the Society for Experimental Biology and Medicine, 21 (7):274-280.*

Koumanov, F., Bozadjieva, E., Andreeva. M., Platonva. E., Ankov. V. (1982). Clinical trial of Tribestan. *Journal of Experimental Medicine, 1:2-4*

Morakinyo, A.O., Adeniyi, O.S. and Arikawe, A.P. (2008). Effects of *Zingiber officinale* on reproductive functions in male rat. *African Journal of Biomedical Research, 11: 329-333.*

Olowosulu, A. K. and Ibrahim, Y. K. E. (2006). Studies on the antimicrobial screening of Aqueous extracts of five plants used in folk medicine in Nigeria. *West African Journal of Biological Science, 3 (5): 21-26.*

Robak, J. and Gryglewski, R.J. (1988). Flavonoids are scavengers of superoxide anions. *Biochemistry and Pharmacology, 37:837-841.*

Singh, B. and Makkar, H.P.S. (2009). The potential of mulberry tree foliage as an animalFeed supplement in India.www.fao.org/ag/aga/agap/frg/mulberry/papers/HTML/Singh&M.htm.

Tomova, M., Gjulemetova, R., Zarkova, S., Peeva, S., Pangarova, T., Simova, M. (1981). Steroidal saponins from *Tribulus terrestris* L. with a stimulating action on the sexual functions. *International Conference of Chemistry and Biotechnology Biol. Act. Nat. Prod.(Proc)3:298-302.*

Vasudeva, N. and Sharma, S. K. (2007). Post-coital anti fertility activity of Hibiscus *Rosa sinensis* Linn. Roots. *Oxford Journals, 5(1):91-94.*

Zemjanis, R. (1970). Collection and evaluation of semen. In: Diagnostic and Therapeutic techniques in Animal Reproduction.2nd Edition, *Williams and Wilkins Co. Baltimore MD, pp 139-156.*

52 PROXIMATE COMPOSITION OF RAW AND PROCESSED FULL-FAT LEBBECK (Albizia lebbeck) SEEDS

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ABSTRACT

This study was carried out to determine the proximate composition of the full-fat composition of raw and processed (boiled) Albizia lebbeck seeds. The crude protein was in the range of 28.03 to 28.35% for the raw and processed seeds respectively. There was the occurrence of slight changes in the content of crude protein, moisture and nitrogen-free extract after the processing of the lebbeck seeds but this was with the exemption of the crude fibre, ether extract and ash contents. It was observed from the results that the crude fibre dropped from 18.50 in the raw seeds to 16.98% in the processed seed with a change of 8.22%, and the ash content reduced from 4.52 in the raw seeds to 4.02% in the processed seeds, with a percentage reduction of 11.06 and the ether extract increased from 11.06% in raw seeds to 12.0% upon processing. In this experiment, the proximate analysis showed that Albizia lebbeck can be a potential plant protein source for incorporation in livestock feeds with proper processing.

KEYWORDS: Proximate composition; full-fat; *Albizia lebbeck;* processing; raw

INTRODUCTION

Conventional feed sources in Nigeria can no longer meet the ever-growing poultry industry. Additionally, these feedstuffs are expensive. Notwithstanding, in Nigeria, there are several non–conventional leguminous seeds which are underexploited. One of such is lebbeck (*Albizia lebbeck*), which is a leguminous plant that produces seed grains that is readily available. It is also a tropical legume and one of the most widespread species worldwide. Lebbeck is an unconventional feed source that may be capable of boosting poultry production. There is a need to utilize this unconventional feed ingredient that is not fully exploited as a possible potential protein source for poultry. Raw lebbeck seeds contain antinutritional substances that could be toxic when consumed by animals as such there is the need to know the best processing method that will eliminate these factors and make it safe as well as palatable for the animals. The use of processed lebbeck seed could serve as a potential protein source for poultry feeding.

According to Fagbemi *et al.* (2005), processing can effectively reduce the antinutritional factors in seeds, notably boiling as a processing method increased the *in vitro* multienzyme protein digestibility of seeds. Proper processing is required to improve the nutritional quality of legume grains, sometimes a combination of more than one processing method may be employed (Akande and Fabiyi, 2010).

Nutritional data on boiled lebbeck seeds is limited to the best of the authors' knowledge, therefore, this experiment was carried out to determine the proximate composition of lebbeck seeds for possible consideration as a potential unconventional feedstuff.

MATERIALS AND METHODS

Sample collection and procedure employed for processing lebbeck seeds

Dry pods of *Albizia lebbeck* were harvested from lebbeck trees in Minna, Niger State, Nigeria. Raw seeds were removed from lebbeck pods by threshing with a mortar and pestle. After threshing seeds were separated from the chaff and other debris. About ten kilogrammes (10 kg) of raw lebbeck are boiled in 20 litres of water at 100℃ for 30 minutes. The lebbeck seeds were then poured into a sieve to drain the water from the seeds. After cooling the seeds were sun-dried for 3 days. After drying, the lebbeck seeds were grounded with the use of a hammer mill.

Proximate analyses

The proximate analyses of lebbeck seeds (both raw and processed seeds) were carried out at the Animal Production Laboratory, Federal University of Technology, Minna, Niger State, Nigeria using the methods outlined by the Association of Official Analytical Chemists (AOAC, 2000). The parameters determined were: moisture content, crude protein, ether extract, crude fibre, ash and nitrogen-free extract.

RESULTS AND DISCUSSION

The proximate composition of the raw and processed lebbeck seeds is presented in Table 1. The values obtained from the results showed that some proximate content of raw and processed lebbeck seeds were generally comparably close, for instance, the crude protein, moisture content and nitrogen-free extract, except the crude fibre, ether extract and ash content. The crude protein was in the range of 28.03 to 28.35% for the raw and processed seeds respectively. The crude fibre dropped from 18.50 in the raw seeds to 16.98% in the processed seeds with a change of 8.22%, and the ash content reduced from 4.52 in the raw seeds to 4.02% in the processed seeds, with a percentage reduction of 11.06 whereas the ether extract increased from 11.06% in raw seeds to 12.0% upon processing. The reduction in some proximal content may be due to the loss of nutrients through leaching during the boiling process. Akande (2004) reported a similar observation for raw and processed jack bean seeds. Tsado *et al.* (2018) reported a crude protein of 22.93% for fermented and toasted lebbeck seed, this value is rather lower than the crude protein of 28.35% obtained in this study. However, the crude protein obtained by Adegbehingbe *et al.* (2018) was 36.31% which is much higher than the value recorded in this research study. This variation in the crude protein may probably be due to differences in the method employed in processing the lebbeck seeds.

Table 1: Proximate composition of raw and processed full-fat lebbeck (*Albizia lebbeck*) seeds

Nutrients	Raw lebbeck seeds	Processed lebbeck seeds	Percentage change (%)
Moisture content	8.19	8.20	0.12
Crude protein	28.03	28.35	1.14
Crude fibre	18.50	16.98	8.22
Ash	4.52	4.02	11.06
Ether extract	11.06	12.00	8.50
Nitrogen free extract	29.70	30.45	2.53

CONCLUSION

In this study, the proximate analysis revealed that lebbeck seeds can be a promising plant protein feed resource for livestock with proper processing. In addition, processing (boiling) did not negatively affect the major proximate fractions which are the crude protein, crude fat and nitrogen-free extract.

REFERENCES

Adegbehingbe, K.T., Fakoya, A., Adeleke, B.S., Adejoro, D.O. & Jemilaiye, T.A. (2018). Effect of fermentation on the nutrient and antinutrient contents of lebbeck (*Albizia lebbeck*) seeds. *Journal of Emerging Trends in Engineering and Applied Sciences*, 9(5):227-233.

Akande, K.E. (2004). Proximate composition and amino acid profile of raw and processed seeds of jackbean. (*Canavalia ensiformis*) (L) (DC). *African Journal of Natural Sciences*, 7:50-51.

Akande, K.E. & Fabiyi (2010). Effect of processing methods on some antinutritional factors in legume seeds for poultry feeding. *International Journal of Poultry Science*, 9(10): 996-1001.

AOAC (2000). Official Methods of Analysis. Association of Official Analytical Chemists. (17th ed). Gaithersburg, Maryland, USA.

Fagbemi, T. N., Oshodi, A. A., & Ipinmoroti, K. O. (2005). Processing effects on some antinutritional factors and *in vitro* multienzyme protein digestibility (IVPD) of three tropical seeds: breadnut (*Artocarpus altilis*), cashew nut (*Anacardium occidentale*) and fluted pumpkin (*Telfairia occidentalis*). *Pakistan Journal of Nutrition*, 4(4), 250-256.

Tsado, D.N., Dikko, A.H., Alabi, O.J., Kperun, T.N., Jiya, B.K., Ojapah, M.O., Ibrahim, A & Olatunji, B.D. (2018). Performance and nutrient digestibility of broiler chickens fed graded levels of fermented and toasted *Albizia lebbeck* seed meal. *Nigerian Journal of Animal Production*, 45(2): 150-156.

53 GINGER (*ZINGIBER OFFICINALE*) AS FEED SUPPLEMENT: INFLUENCE ON GROWTH PERFORMANCE AND HEALTH OF GROWING RABBITS – A REVIEW

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Abstract

Ginger (Zingiber officinale) is a plant that has gained wide usage as a spice in foods. This is due to its appealing aromatic flavor and spicy kick it gives to foods when used as condiment. In recent times, investigations have revealed that there are other valuable uses to which the ginger roots can be put to. The use of ginger as supplement in feeds of rabbits has been successful as the plant was found to enhance growth performance and the quality of life of the animals used in such feeding trials. Not only has it been used as feed supplement for monogastrics (poultry, rabbits etc.), it has also been found to command immense therapeutic qualities. Production of rabbits can be marred by disease outbreaks and this can affect the overall return on investment of the livestock producer whose aim is to make profit. The roots of Z. officinale have been found to possess anti-oxidative, antimicrobial and anti-inflammatory qualities. With the rising cost of drugs and the potential risks of antibiotics on human health, effective utilization of Z. officinale in disease prevention and control in rabbits could be a viable and cost effective means of ensuring wholesome production of animals and animal products. This review therefore, itemized the benefits of ginger and how it affects the growth performance and health of rabbits.
Keywords: rabbits, ginger, growth, health, nutrient, feed

Introduction

The task of attaining food security in any nation does not only involve making food available for the populace but to also ensure that such food is of good nutritional profile (Gavrilova, 2020). Human diet devoid of sufficient animal protein predisposes consumers of such diets to nutritional health challenges (Pezeshki *et al.*, 2016). In Nigeria, the daily animal protein intake averages 10g per person per day and this is a far cry from the recommended daily intake of 50g-60g per person per day (Denisova, 2015). This has led to an increase in efforts of researchers and livestock producers at developing nutritional strategies that could help ameliorate this shortfall. Rabbit production has been reported to possess the potential for upgrading animal protein intakein Nigeria (Kalio *et al.,* 2008). Production of rabbits is favourable due to their fast growth rate, limited space requirement, high reproductive ability, ability to survive on kitchen wastes and a quick return on investment (Okojie *et al.,* 2004)
Ginger (*Zingiber officinale*) is the rhizome of a plant commonly utilized as a spice because of its rich flavour (Taiwo *et al.*, 2005) or for its medicinal or therapeutic importance (Balogun *et*

al., 2019). Ginger rhizome contains useful nutrients appropriate for feeding to monogastrics (Ajayi et al., 2013). Ginger has been reported to contains certain ingredients with growth promoting abilities that could make it fitting for use as an Antimicrobial Growth Promotant in feed (Imaseun et al., 2014). The use of ginger as supplement in feed of growing rabbits, has been reported to significantly enhance growth performances (Bakr et al, 2016; Jubril, 2019). The health benefit of ginger supplementation has been widely investigated. Addition of ginger in diets of growing rabbits has been reported to exert antimicrobial (Azu and Onyeagba, 2007), anti-inflammatory (Rahmnani *et al.*, 2014) and antioxidant activities (Santos-Sánchez, *et al.*, 2019).

This review therefore attempts to investigate the effects of ginger (*Zingiber officinale*) supplementation on growth and health of growing rabbits.

Influence of ginger (*Zingiber officinale*) on growth performance of rabbits

The major indicators of growth performance include the extent of an animal's daily feed and water intake, body weight gain and ultimately, the frequency at which ingested feed is converted into meat. The use of ginger as supplement in the feed of animals has been shown to promote palatability of feed thereby encouraging animals to consume more feed (Choudhury, 2015). Supplementation of rabbit diets with natural antioxidants such as ginger has been reported to produce varied effects (Abdel-Khalek, 2013). According to Omage *et al.* (2007) when ginger waste meal was supplemented in the diets of growing rabbits, feed and water intake of rabbits increased but the increases did not influence weight gain, final live weight and feed conversion efficiency in the rabbits. Similarly, Emmanuel and Ochefu (2020) reported that supplementation of dried ginger root meal enhanced feed intake in growing rabbits. According to the authors, feed and water intake in the rabbits increased with increasing inclusion levels of the dried ginger root meal diets across treatment groups. According to Jubril (2019), an increase in feed and water intake which led to a significant ($P<0.05$) influence on body weight gains of growing rabbits was observed when powdered ginger was supplemented in rabbis diets. The author reported that the higher feed intake by the rabbits could have been due to the attractive flavour of the powdered ginger. Similarly, Ocampo-Lopez *et al.* (2022) showed that growing rabbits fed ginger at 0.5g/100g of feed had showed higher daily weight gain and feed conversion ratios across all treatment groups. Studies have shown that growth performances and health of rabbits can be improved through supplementation of diets with aromatic herbs and essential oils (Gerencser *et al.*, 2014). Ginger has been shown to be rich in essential oils useful in feeding rabbits because of their influence on the growth performances, health and meat quality of growing rabbits (Elazab et al., 2022). Constituents of ginger essential oil enhance immune function in animals, thereby promoting health (Mahomoodally, 2021). In a study with New Zealand White (NZW) rabbits, Elazab et al. (2022) showed that dietary supplementation of ginger essential oils significantly promoted better growth performance and feed utilization efficiency of the growing rabbits. Supplementation with higher doses of essential oils could be beneficial since a sharp increase in growth performance and feed utilization values were observed when the essential oils were supplemented at a high dose of 0.5%.

Ginger and its antioxidant effect in rabbits

Ginger is abundant in oleoresin, terpene, carotenoids, and phenolic compounds (Hassan, *et al.*, 2012). Phenols found in ginger include paradols, gingerols, and shogaols. These phenols act as antioxidants in the system of rabbits by binding with free radicals. Free radicals in the body have the capacity to damage rabbits' DNA and active proteins. To prevent this, phenols present in Ginger will inhibit oxidation caused by these radicals (Santos-Sánchez, *et al.,* 2019). By exerting its antioxidant properties, the phenolic compounds present in ginger help to decrease the incidence of neurodegenerative conditions in rabbits. Such conditions include stomach cancer (Yoshida *et al.,* 1990) and cardiovascular diseases (Paran, *et al.,* 2009). To limit the occurrence of cardiovascular diseases, phenols present in ginger causes vasorelaxation. This decreases the tension on the walls of rabbits' blood vessels. The antioxidant effect of ginger also works synchronously with its anti-allergy effects (Sakakibara *et al.*, 2003).

Ginger and its anti-inflammatory effects

The major inflammatory mediators present include interleukin-1 (IL1), cytokines, and tumour necrosis factor (TNF) (Rahmnani *et al.*, 2014). Although there are anti-inflammatory drugs that can be used to battle inflammation in rabbits, they have side effects like ulcers while some are contraindicated in some conditions (Rahmnani *et al.*, 2014). Hence, it is best to resort to the use of natural anti-inflammatory agents like ginger. Ginger can be constituted in various forms to derive its active ingredients. These forms include ginger oil and ginger powder. A study has shown that when ginger oil was administered at a dosage of 33mg/kg, it aided in repressing joint swellings which may be due to arthritis, synovitis, and other inflammatory conditions (Sharma et al., 1994). Ginger has also been clinically proven to inhibit the synthesis of cytokines like IL-8 and IL-1 (Verma *et al.*, 2004). Another study has revealed that the manner in which TNF is increased when rabbits have cancerous hepatic cells is blocked by using ginger extracts (Habib, *et al.*, 2008). It further inhibits COX activity and prevents the induction of genetic codes that controls inflammation (Tjendraputra *et al.*, 2001).

Ginger and its anti-microbial activity

The rate at which microbes are getting resistant to antimicrobials is alarming and this can be attributed to the abuse of antimicrobials. Previous research has revealed that ginger and its active ingredients play a pivotal role in the inhibition of the growth of microbes. A study has shown that ginger specifically inhibits the growth of *Bacillus subtilis*, *Salmonella typhi*, and *Escherichia coli* (Azu and Onyeagba, 2007). Ginger extract dipped in ethanol has shown a very wide inhibition zone against *Salmonella typhi* and *Streptococcus spp* (Giriraju and Yunus, 2013). Not only does ginger have the capacity to prevent bacteria growth, its rhizome also possesses some anti-fungal properties. As mentioned earlier, phenols are an active constituent in ginger plants. Shagelol and gingerol, a subform of phenols fight actively against fungal agents. Phenolic compounds present in ginger extract inhibit the action of *Candida albicans*, a fungus that causes cutaneous candidiasis in rabbits (Teodoro *et al.*, 2015). Phenols present in ginger act against the above factors. However, their degree of activity varies from one phenolic compound to another. Some phenolic compounds prevent hyphae formation (Zhang, *et al.*, 2011) while some prevent biofilm formation (Teodoro, *et al.*, 2015). Gingerol from the rhizome of ginger has also been proven to limit the growth of periodontal bacteria in rabbits (Miri *et al.*, 2008) and also inhibit *Mycoplasma tuberculosis* in vitro (Hiserodt *et al.*, 1998). Microbes that cause periodontal infection in rabbits are usually gram-negative and they grow anaerobically.

Conclusions

The ultimate goal of livestock producers is the production of wholesome animals that will serve as good quality meat, promote health and improve the quality of life of consumers of such animal products. There is an increasing interest on the part of researchers to find out suitable alternatives to most drugs used in livestock production in recent times. Ginger (*Z.officinale*) has been shown to possess active ingredients that enhance growth performance in rabbits and also deplete a wide range of disease-causing microbes. *Z. officinale* could be a suitable alternative to most anti-microbial, anti-inflammatory and anti-oxidant drugs because of the immense protection it offers to rabbits. The use of ginger as feed supplement in rabbit production is therefore a means of achieving cost effective rabbit production since ginger is readily available and affordable to most rabbit farmers. Because of its therapeutic qualities, the use of *Z. officinale* in rabbit production will also promote production of healthy rabbits thereby improving the farmers' returns on investment.

References

Abdel-Khalek, A.M. (2013). Supplemental antioxidants in rabbit nutrition: a review. *Livestock Science*, 158: 95–105.

Ajayi, B.O., Akomolafe, F.S.& Akinyemi, F.T. (2013). Food value of two varieties of ginger (*Zingiber officinale*) commonly consumed in Nigeria. ISRN Nutrition, http://dx.doi.org/10.5402/2013/

Azu, N., Onyeagba, R. (2007). Antimicrobial Properties of Extracts Of Allium cepa (Onions) and Zingiber officinale (Ginger) On Escherichia coli, Salmonella typhi and Bacillus subtilis. *The Internet Journal of Tropical Medicine*, 3:1–10.

Bakr, E.S., Ibrahim, I., Mousa, M., Shetaewi, M., Abdel-Samee, A.S. (2016). Rosemary, marjoram and ginger as a feed additives and its influences on growth performance traits of NEZ rabbits under Sainai conditions. *Journal of Productivity and Development (Agri. Res.)* 21, 1–18.

Balogun, F.O., AdeyeOluwa, E.T. & Ashafa, A.O.T. (2019). Pharmacological potentials of ginger. In (Ed.), Ginger Cultivation and its Antimicrobial and Pharmacological Potentials. IntechOpen, https://doi.org/10.5772/intechopen.88848

Choudhury, J. E. (2015). Effects of addition of ginger root powder as natural feed additive. *American Journal of Animal Science*, 14:45-49.

Denisova, T.S. (2015).Nigeria 2015: Leadership Change. Asia and Africa today, 8: 12-17

Elazab, M.A., Khalifah, A.M., Elokil, A.A., Elkomy, A.E., Rabie, M.M., Mansour, A.T. and Morshedy, S.A. (2022). Effect of Dietary Rosemary and Ginger Essential Oils on the Growth Performance, Feed Utilization, Meat Nutritive Value, Blood Biochemicals, and Redox Status of Growing NZW Rabbits. *Animals*, 12: 375. https://doi.org/10.3390/ani12030375

Emmanuel, B. & Ochefu, J. (2020). Effects of graded levels of ginger root meal on the performance and carcass parameters of growing rabbits. *Nigerian Journal of Animal Science*, 22(2): 255-261

Gavrilova, N. (2020). Improving food security in Nigeria through livestock innovation. E3S web of conferences, 176:01010 https://doi.org/10.1051/e3sconf/202017601010

Gerencser, Z., Szendr€o, Z., Matics, Z., Radnai, I., Kovacs, M., Nagy, I., Cullere, M., Dal Bosco, A. and Dalle Zotte, A. (2014). Effect of Dietary supplementation of Spirulina (Arthrospira platensis) and Thyme (Thymus vulgaris) on apparent digestibility and productive performance of growing rabbits. *World Rabbit Science*, 22:1–9.

Giriraju, A., Yunus, G.Y. (2013). Assessment of the antimicrobial potential of 10% ginger extract against *Streptococcus mutans, Candida albicans, and Enterococcus faecalis* an in vitro study. *Indian Journal of Dental Res*earch, 24:397–400.

Habib, S.H., Makpol, S., Abdul Hamid, N.A., Das, S., Ngah, W.Z., Yusof, Y.A. (2008). Ginger Extract (Zingiber Officinale) has Anti-Cancer and Anti-Inflammatory Effects on

Ethionine-Induced Hepatoma Rats. *Clinics*, 63:807–813.
Hasan, H.A, Rasheed, A.M., Abd Razik, B.M., Rasool, B.A. (2012). Pharmaceut Chemical Composition and Antimicrobial Activity of the Crude ExtractsIsolated from Zingiber Officinale by Different Solvents. *Pharmaceute Anat Acta*, 3:184.
Hiserodt, R.D., Franzblau, S.G., Rosen, R.T. (1998). Isolation of 6-, 8-, and 10-Gingerol from Ginger Rhizome by HPLC and Preliminary Evaluation of Inhibition of Mycobacterium avium and Mycobacterium tuberculosis. *Agriculture Food Chemistry*, 46:2504–2508.
Imasuen, J. A, Otoikhian, C. S. O. and Igue, U. B. (2014). Growth and haematological performance of rabbits fed varying levels of ginger powder as supplemented diet introduction. *Indo-America Journal of Pharma and Bioscience*, 2 (1): 1-9
Jubril, T.O. (2019). Growth Performance and Digestibility in Growing Rabbits Fed Diet Supplemented with Powdered Ginger. *Asian Journal of Research in Animal and Veterinary Sciences*, 4(4): 1-5
Kalio, G.A., Etela, I. & Ginika, V.E. (2008). Rabbit meat as preferred animal protein source in Ekpeyekingdom of Rivers State, Nigeria. *Livestock Research for Development*, 20:9 https://www.lrrd.org/lrrd20/1/kali20009.htm
Mahomoodally, M., Aumeeruddy, M., Rengasamy, K.R., Roshan, S., Hammad, S., Pandohee, J., Hu, X. and Zengin, G. (2021). Ginger and its active compounds in cancer therapy: From folk uses to nano-therapeutic applications. Proceeding of Seminar on Cancer Biology, 69:140–149.
Miri, P., Bae, J. and Lee, D.S. (2008). Antibacterial activity of [10] -gingerol and [12] -gingerol isolated from ginger rhizome against periodontal bacteria. *Phytothery Research*, 22:1446–1449.
Ocampo-López, J., García-Vázquez, L. M., Ayala-Martínez, M., Soto-Simental, S. and Zepeda-Bastida, A. (2022). Effects of Zingiber officinale as a feed additive on productive parameters, carcass quality, and meat quality in growing rabbits. *Revista Brasileira de Zootecnia*, 51:e20200203. https://doi.org/10.37496/rbz5120200203
Okojie, L.O., Ayinde, I.A. & Alli, A.O. (2004). Economic analysis of rabbit production: on-farm research approach. *Nigerian Journal of Animal Production*, 31(2): 230-236
Omage, J.J., Onimisi, P.A., Adegbite, E.K. & Agumbiade, M.O. (2007). The effects of ginger (*Zingiber officinale*) waste meal on growth performance, carcass characteristics, serum lipid and serum cholesterol profiles of rabbit. *Pakistan Journal of Nutrition*, 6(4): 359-362
Paran, E., Novack, V., Engelhard, Y.N. and Hazan-Halevy, I. (2009). The effects of natural antioxidants from tomato extract in treated but uncontrolled hypertensive patients. *Cardiovascular Drugs and Therapy*, 23(2):145-151. https://doi.org/10.1007/s10557-008-6155-2
Pezeshki, A., Zapata, R.C., Arashdeep, S. Yee, N.J. & Chelikani, P.K. (2016). Low energy diets produce divergent effects on energy balance. *Scientific reports*, 6:25145 https://doi.org/10.1038/srep25145
Rahmani, A. H., Shabrmi, F. M. and Aly, S. M. (2014). Active ingredients of ginger as potential candidates in the prevention and treatment of diseases via modulation of biological activities. *International Journal of Physiology, Pathophysiology and Pharmacology*, 6 (2), 125–136.
Sakakibara, H., Honda, Y., Nakagawa, S., Ashida, H., Kanazawa, K. (2003). Simultaneous determination of all polyphenols in vegetables, fruits, and teas. *Journal of Agricultural and Food Chemistry*, 51:571-581.
Santos-Sánchez, N.F., Salas-Coronado, R., Villanueva-Cañongo, C., Hernández-Carlos, B. (2019). Antioxidant Compounds and Their Antioxidant Mechanism.In(Ed.), Antioxidants. IntechOpen. https://doi.org/10.5772/intechopen.85270.

Sharma, M., Shukla, S. (1977). Hypoglycaemic effect of ginger. *Journal of Research in Indian Yoga and Homoeop*, 12:127–130.

Taiwo, A.A., Adejuigbe, A.D., Adebowale, E.A., Oshitan, J.S. & David, O.O. (2005). Performance and Nutrient digestibility of weaned rabbits fed forages supplemented with concentrate. *Nigerian Journal of Animal Production*, 32 (1): 74-78

Teodoro, G. R., Ellepola, K., Seneviratne, C. J., & Koga-Ito, C. Y. (2015). Potential Use of Phenolic Acids as Anti-Candida Agents: A Review. *Frontiers in microbiology*, 6: 1420. https://doi.org/10.3389/fmicb.2015.01420.

Tjendraputra, E., Tran, V.H., Biu-Brennan, D., Roufogalis, B.D. and Duke, C.C. (2001). Effect of ginger constituents and synthetic analogues on cyclooxygenase-2 enzyme in intact cells. *Bioorganic Chemistry*, 29:156–163.

Verma, S.K., Singh, M., Jain, P. and Bordia, A. (2004). Protective effect of ginger, Zingiber officinale Rosc on experimental atherosclerosis in rabbits. *Indian Journal of Experimental Biology*, 42:736–8.

Yoshida, M., Sakai, T., Hosokawa, N., Marui, N., Matsumoto, K., Fujioka, A. (1990). The effect of quercetin on cell cycle progression and growth of human gastric cancer cells. *FEBS Letters*, 260 (1):10-13. https://doi.org/10.1016/0014-5793(90)80053-L.

Zhang, L., Chang, W., Sun, B., Groh, M., Speicher, A. and Lou, H. (2011). Bisbibenzyls, a new type of antifungal agent, inhibit morphogenesis switch and biofilm formation through upregulation of DPP3 in Candida albicans. PLoS ONE 6:e28953 10.1371/journal.pone.0028953.

54 ASSESSMENT OF MIXTURES MEAL OF BREWERS DRIED GRAINS AND SORGHUM BREWERS DRIED GRAINS ON GROWTH AND NUTRIENT DIGESTIBILITY OF WEANER RABBITS

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Abstract
Seventy-five (75) weaned rabbits aged between 5 and 6 weeks and of mixed breeds and sexes, with average initial weights of 450g were used to assess the growth performance and nutrient digestibility of mixtures meal of brewers dried grains and sorghum brewers dried grains of weaner rabbits (Oryctolagus cuniculus) fed at varying levels of inclusion. The rabbits were allotted into five dietary treatments; T_1 (0 % as the control diet), T_2, T_3, T_4 and T_5 (containing 10, 20, 30 and 40% of mixtures of brewers dried grains) and sorghum brewers dried grains of three (3) replicates with five (5) rabbits per replicate in a completely randomized design. Data were collected on growth performance and nutrient digestibility, the trial lasted twenty weeks. Data generated from the trial were subjected to analysis of variance (ANOVA). The result showed that all the parameters determined (initial weight, final weight, total weight gain, daily weight gain, total concentrate intake, total feed intake, weekly feed intake and feed conversion ratio) were not significantly (p>0.05) affected by the test ingredients in all the treatment groups. The parameters measured were all significantly affected in all the treatment groups.
Keywords: Sorghum, brewers dried grain, nutrient, growth, digestibility

INTRODUCTION

In recent times, Nutritionists have highlighted the vital role of animal protein in human health, especially during pregnancy and subsequent development of children. Maternal protein intake throughout pregnancy is related to birth size, and future viability of children. Where protein shortage occurs, dietary protein from any source is important in human development; but increased intake of animal protein appears superior for future development. shortage of dietary protein in particular have had a greater effect on prenatal development and size of the new-born child (Moore, 2002). Sorghum Brewers Dried Grains (SBDG) on the other hand is the by-product of brewery based on sorghum grains (other grains such as barley, maize and rice are sometimes included). It can be used fresh or dried (artificially or sun-dried). Sorghum has been the basis for traditional African beers such as the local beer of West-Africa *dolo, burukutu, pito* and the opaque beer of the Southern Africa. Though the power of the sorghum malt is very low; certain stout and larger beers are now produced in Africa using malted sorghum rather than the imported and expensive barley.

In this research work, Brewers dried grains (BDG) industrially sourced from barley and Sorghum brewers dried grains (SBDG) locally sourced from red sorghum 50:50 Mixture of BDG and SBDG were used to assess the performance and nutrient digestibility of rabbits in the humid tropics of Nigeria.

Aim of the Study

The aim is to assess the growth performance and nutrient digestibility of weaner rabbits fed mixtures meal of brewers dried grains and sorghum brewers dried grains

The objectives of the Study are to:

i. to evaluate the effects of different levels of mixtures of industrially produced brewers dried grains (BDG), locally produced sorghum brewers dried grains (SBGD) (50:50) on growth rabbits.
ii. to examine the effects of different levels of mixtures of industrially produced brewers dried grains (BDG), locally produced sorghum brewers dried grains (SBGD) (50:50) on growth rabbits.

METHODS ANND MATERIALS

Experimental Site

The research was conducted at the Teaching and Research Farm of the Department of Animal Production, School of Agriculture and Agricultural Technology, Federal University of Technology, Minna, Niger State, Nigeria. Minna is situated between latitude 9^{o} 31′ and longitude 9^{0} 45′ North, and Longitude 6^{0}31′ and 6^{0}45′ East of the equator (Usman, 2011).

Source of Experimental Animals, Test Ingredients and Their Management

Seventy-five (75) weaner composite breeds of rabbits were obtained from the rabbitry unit of Ministry of Livestock and fisheries Department, Bosso, Minna Niger State. They were of mixed breeds and sexes (forty-five females and thirty males), aged 5-6 weeks and weighing between average of 449.00-490.70 g were randomly allotted to five treatment groups. Each treatment had three replicates with five rabbits per replicate (two males and three females), five diets were formulated and designated as T1, T2, T3, T4 and T5 (0, 10, 20, 30 and 40 % dietary inclusion of BDG respectively). T1 was the control diet and contained ground nut cake and maize as the main protein and energy sources with no brewers dried grains inclusion while T2, T3, T4 and T5 contained 10, 20, 30 and 40 % inclusion levels of industrially produced brewers dried grains respectively. All diets were supplemented with equal amount of bone meal, salt and vitamin-mineral premix. The diets were supplemented with 10 g of *Amaranthus hybridus* (about 10 g dry matter) per rabbit each day in addition to concentrate ration to improve the fibre supply in the diet. The rabbits were housed intensively in well-constructed hutches that were made of wire and woods with trays to collect the faeces as well as for easy cleaning of the hutches. The hutches were equipped with feeders and drinkers. They were cleaned twice a day throughout the study period. The rabbits were dewormed against endoparasites using ivermecin, Coccidiosis was treated using Sulphadimidine and multivitamin soluble powder (Vitalyte) were given as an anti-stress. In addition, medications were administered where and when necessary. Prior to the start of the experiment, the animals were fed common diets and allowed an adjustment period of one week (seven days) to enable the animals get acclimatized to their cages and diets

DATA COLLECTION

Data were collected using the following formulae on Total feed intake (g) = Total quantity of feed served (g) – Total quantity of leftover (g)Weight gain (g) = Final body weight at twenty weeks (g) – Initial body weight at first week (g)

$$\text{Feed conversion ratio} = \frac{\text{Total feed intake (g)}}{\text{Total weight gain (g)}}$$

Nutrient Digestibility Trial

$$ADN = \frac{\text{Amount of nutrient in feed consumed - Amount of nutrient in droppings voided}}{\text{Amount of nutrient in feed consumed}} \times \frac{100}{1}$$

Statistical Analysis Data generated from the study were subjected to analysis of variance (ANOVA). Using statistical package (SAS) 2002. The package based on the Completely Randomized Design (CRD) model

RESULTS AND DISCUSSION

Table 1: Proximate composition and energy contents of the mixture diets of BDG and SBDG meal

	Levels 0f the mixture meal (%)				
C0mp0siti0n	TI	T2	T3	T4	T5
	0	10	20	30	40
Dry matter	93.99	87.42	94.12	94.51	93.93
Crude Pr0tein (%)	19.21	20.75	20.75	20.87	22.75
Crude fibre (%)	17.60	17.80	17.40	17.80	18.10
Ether extract (%)	7.37	7.02	7.48	7.69	7.90
Ash (%)	5.19	9.87	8.37	10.26	13.94
Nitr0gen free extract	44.62	31.98	40.12	37.89	31.24
ME (Kcal/kg)	2621.00	2638.00	2572.00	2583.10	2518.00

DISCUSSION

Effects of Different Dietary Inclusion Levels of the Mixture Meal of BDG and SBDG on Growth Performance of Rabbits (*Oryctolagus cuniculus*) 0 – 20 Weeks

The results of growth performance of rabbits fed diet containing BDG and SBDG mixture meal are presented in Table 2. The result revealed that all the parameters determined (initial weight, final weight, total weight gain, daily weight gain, total concentrate intake, total feed intake, weekly feed intake and feed conversion ratio) were also not significantly (p>0.05) affected by the test ingredients in all the treatment groups. Final body weight gain (1819.67 - 1979.92 g) obtained in this trial were within the values (1805 – 2040 g) obtained by Abubakar *et al*. (2006) and higher than 1160.00 – 1470.70 g recorded by Igwebuike *et al.* (2013) when rabbits were fed two varieties of sorghum as replacement for maize as energy source in tropical environments. These differences could be probably due to breeds, diets and duration of the research may be among other factors responsible for the differences in the final weights.

The daily weight gain (g) obtained in this study 9.78 - 10.93g were also within 8.86-15.54 g recorded by (Igwebuike, 2013) and far lower than (22.37- 25.72 g) and (10 – 20 g) obtained by Abubakar *et al*., (2006) and Cheeke (1987) for rabbits reared in tropical countries. These variations could be attributed to effect of high ambient temperature about 34^{0}c on feed intake at the time of the study. Despite the non-significant difference observed, Olorumisoro *et al.* *(*2002) concluded that sorghum brewers dried grains stimulate better weight gain when the authors fed weaner rabbits sorghum brewers dried grains diets.

The variation in values of fed intake might be due to tannin content in the diet that was high. Despite the non-significant effects recorded and could be an indication that mixture diet has better feed conversion ratio.

Table 2: Effects of different dietary inclusion of mixture meal of industrially produced brewers dried grains and locally produced sorghum brewers dried grains on growth performance of rabbits (*Oryctolagus cuniculus)* 0-20 weeks

Levels of mixture meal (%)									
	T1	T2	T3	T4	T5				
Parameters	0	10	20	30	40	SEM	CV	LS	P Value
Initial weight (g)	450.00	445.80	451.70	453.11	458.17	0.06	2.81	*	0.00
Final weight (g)	1819.67	1851.67	1964.00	1919.60	1979.92	542.39	4.89	NS	0.38
Total weight gain (g)	1369.67	1405.87	1512.30	1469.49	1521.75	31.13	3.56	NS	0.49
Daily weight gain (g)	9.78	10.04	10.80	10.47	10.87	0.23	5.06	NS	0.37
Total conc. Intake (g)	10426.67	10427.33	10426.00	10426.67	10358.00	59.83	0.99	NS	0.88
Total forage intake (g)	1400.00	1400.00	1400.00	1400.00	1400.00	0.00	0.00	*	0.00
Total feed intake (g)	11826.67	11827.33	11826.00	11826.67	11758.00	59.83	0,88	NS	0.89
Daily feed intake (g)	84.48	84.48	84.47	84.48	83.99	0.52	1.06	NS	0.85
Feed conversion ratio	8.64	8.41	7.82	8.07	7.73	0.31	5.002	NS	0.29

Table 3: Effects of different dietary inclusion levels of the mixture meal of BDG and SBDG on nutrient digestibility of rabbits (*Oryctolagus cuniculus)*

Levels of mixture meal %									
	T1	T2	T3	T4	T5				
Parameters	0	10	20	30	40	SEM	CV	LS	P Value
Dry matter	69.75^{a}	70.35^{a}	67.16^{ab}	64.77^{c}	68.34^{ab}	0.73	1.85	*	<.00
Crude protein (%)	54.94^{c}	62.62^{a}	55.58^{c}	56.14^{c}	59.43^{b}	0.95	2.85	*	<.00
Crude fibre (%)	63.28^{b}	74.07^{a}	57.13^{c}	54.43^{c}	48.18^{d}	0.99	2.91	*	<.00
Ether extract (%)	54.46^{c}	50.36^{d}	48.66^{d}	61.44^{a}	57.69^{b}	0.95	3.03	*	<.00
Ash (%)	28.29^{a}	16.19^{b}	16.74^{b}	16.90^{b}	12.12^{b}	1.74	16.72	*	0.00
Nitrogen free extract	79.40^{b}	78.08^{b}	83.43^{a}	82.35^{a}	74.66^{c}	0.45	0.99	*	<.00
Total digestible nutrient (TDN)	55.60^{c}	64.27^{b}	64.82^{b}	67.74^{a}	67.73^{a}	1.21	15.50	*	0.00

^{abc}Means with the same superscript (s) in the same row are not significantly (P>0.05) different, SEM = Standard Error Mean
CV = Coefficient of Variation, LS = Level of Significance, * = Significant

Nutrient Digestibility of Rabbits (*Oryctolagus cuniculus)* Fed Diets Containing Varying Levels of Mixture Meal of BDG and SBDG

The results of the nutrient digestibility of rabbits fed diets containing varying levels of BDG and SBDG mixture meals are presented in Table 4.26. The parameters measured were all significantly affected in all the treatment groups. Crude protein was within the range of 54.94 % to 62.62 % (T1 to T2) digestibility. Crude fibre had a higher digestibility in T2 and lowest in T5 (74.07 % and (48.18 %). Eather extract had digestibility values ranged between 48.66 % to 61.44 % (T3 and Tt4). Also highest value for ash was recorded in T1 (28.29 %) and the lowest in T5 (12.12 %) and all significantly ($p<0.05$) different in all the treatment groups. The range of Crude Protein digestibility in this study (54.94- 62.62 %) were lower than (69.28 – 84.47 %) and (64.88 – 65.35) recorded by Igwebuike *et a*l. (2013) Crude Protein digestibility result further showed that rabbit fed 10 % (T2) recorded higher value (62.62%). This may be linked to better feed conversion ratio in the diets. The result of crude fibre obtained (48.18 % - 64.07 %) from this study were within the range of 37.44 to 68.15 % reported by Igwebuike *et al.* (2013), Igwebuike *et al.* (1998) and Jegede (2008). Ether extract digestibility also showed significant difference among the treatment groups. Diet 5 (40 % inclusion level) produced a significant higher value 61.44 % than other treatments. The result was within the range of 48.66 to 61.44 % and were below the value of 57.97 to 74.81 % and 65.63 to 85.41 % reported by Igwebuike *et al*. (1998) and Adama *et al.* (2007) when broilers were fed diets containing varying levels of sorghum brewers dried grains and (78.81 to 80.19 %) reported by Murin *et al.* (2002). Ash digestibility values recorded in this trial were in the range (16.19 – 18.29 %) lower than (58.47 to 60.88 %) and 11.70 to 35.60 % reported by Igwebuike *et al.* (2013) and Uko *et al.* (1999) when rabbits were fed cereal by-products as energy source .The variation could probably be attributed to higher dry matter digestibility as reported by Murin *et al.* (2002) in their trial. Total digestible nutrient of the diet was in the range of 55.60 – 67.74 and treatment four and five recorded similar highest values of digestible nutrient of 70.17 each.

Conclusions: The findings of this study can be concluded that mixture of industrially produced brewers dried grains (BDG) and locally produced sorghum brewers-dried grain (SBDG) included at varying inclusion levels is of good nutritional quality. The mixture can be included in the diets of rabbits without any deleterious effects on the growth performance and nutrient digestibility of rabbit.

Recommendations: Based on the conclusions drawn from this study, it is recommended that mixture meal can be included in the diet of weaner rabbits up to 40 % level of inclusion for optimum growth performance and nutrient digestibility rabbits (*Oryctolagus cuniculus).*

REFERENCES

Abubakar, M., Doma, U.D., Kalla, D. J. U, Ngele, M. B, & Augustine, C. L. D. (2006). Effects of dietary replacement of maize with malted and unmalted soghum on performance of weaned rabbits, *Livestock Resource Rural Development*. 18(5). Article 65 Retrieved November 28. http/www.cipav.org.co/irrd18/5/abub18065.htm.

Adama, T.Z., Ogunbajo, S.A, & Mambo, M. (2007). Feed Intake, Growth Performance and Nutrient Digestibility of Broiler Chicks Fed Diets Containing Varying Levels of Sorghum Dried Brewers' Grains. *International Journal of Poultry Science,* 6(8): 592-595

AOAC (2002). Association of Official Analytical Chemicals. Association of Analytical Chemist. Oxford methods of analysis, 13th edition, Washington Royal, 5 (3): 242-247.

Cheeke, P. R. (1987). Rabbit feeding and nutrition. Academic press, Washington D.C., USA.Dalle Zotte, A. (2002). Main factors influencing the rabbit carcass and meat quality. *In Proceeding of the 7th World Rabbit Congress* (Pp. 1-32). Valencia, Spain.

Duncan, D. B. (1955). New Duncans Multiple Range and Multiple F- test. *Biometrics*, 11:1-42.

Igwebuike, J. O, Alade N. K. & Anyi, H. D. (1998). Effects of feeding graded levels of sorghum waste on the performance and organ weight of growing rabbits E. *African Journal of Agriculture* 60(40);193-200.

Igwebuike, J. U, Medugu, C. I., Kwari, I. D. & Dauda, A. (2013). Growth performance and nutrient digestiblilty of growing rabbits fed two varieties of sorghum as replacement for maize as energy source in tropical environment. *Global Journal of Bio-science and Biotechnology*, Volume 2 (2) pp 167-172.

Moore, K. J. & Jung, H. J. G. (2002). Lignin and fibre digestion. *Journal of Range Management*. 54, 420-430.

Murin, P. A, Njoka, E. N., Tuitoek, J. K. & Nanua, J. N. (2002). Evaluation of sorghum as replacement for maize in the diet of growing rabbits, *Swidish Journal of Animal Science*. 15 (4): 565 – 569.

Olorumisoro, O. A., Adewumi, M. K. & Babayemi, O. S. (2002). Effect of Nitrogen level on the Utilization of maize offal and Sorghum brewers grain in sheep diets. *Livestock Research Development*.18(1).Retrievedon May 16, 2007 from http://ww.cipav.org.cv/seed/rrd/six/soham.

Statistical Analysis System (SAS). (2002). Computer Software, *Version 9 Statistic SAS* institute Inc.cary, N.C. 27513, U.S.A.

Ugweibuike, J. U, Medugu, C. I, Kwari, I. D. & Dauda, A. (2013). Growth performance and nutrient digestibility of growing fed two varieties of maize as energy source in tropical environment. *Global Journal of Bio-science and Biotechnology*, 2(2), 167-172.

Uko, O. J., Ataji, A. M. & Tanko, H. B. (1999). Response of rabbits to cereal by products as energy source in diets. *Archives de zoo technia.* 48, 285-294

Usman, H. I. (2011). Effect of time of intercropping soy beans on weed suppression and performance of upland rice in southern guinea savannah of Nigeria. *PhD thesis*, Department of crop production. Federal University of Technology Minna. Pp 2

55 MODELLING OF PHENOTYPIC TRAITS AS DETERMINANTS OF BREEDING POTENTIALS OF CATTLE UNDER LOW EXTERNAL INPUT

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ABSTRACT
The breeding potentials of bulls and cows are determined by relationships between body and testicular measurements which are being used as traits for selection of the cattle. Therefore, the objective of this study is to determine the relationship between the body condition score (BCS), live weight (LW), scrotum circumference (SC) and linear body measurements, body length (BL) and heart girth (HG) in bulls under low external input operation for modelling predictive equation for breeding selection. A total of 40 bulls and cows each selected in two agroecological zones of Nigeria were used for the study. Data collected on body measurements and were subjected to Pearson's correlation to establish relationships between the LW, BL, HG, BCS and SC in bulls and between the LW, BL, HG and BCS in cows; while Multiple regression analysis was used to develop selection models for both the bulls and cows. Pearson's correlation results indicated that BCS had positive statistical correlation with SC ($r = 0.54$) and LW also indicated statistical correlation with HG ($r = 0.99$) in the bulls. In the cows, the result obtained indicated that LW was positively correlation with HG ($r = 0.97$), BL ($r = 0.69$) and BCS ($r = 0.60$). The regression model developed were Testis Circumference = -71.84 + 2.32Age + 2.73Hearth Girth + 0.03Body Length – 0.32Live Weight + 2.56Body Condition Score for bulls, and Age at first calving = 0.75 +1.22LW + 4.73BCS – 3.2Age – 1.07HG -7.76BL + 1.00Age at puberty for the cows. The correlation findings suggest that increasing SC, BCS, LW and HG, and the models developed for these traits could be used for selection of bulls and cows for breeding.

Keywords: *Breeding potentials, Low external input, modelling, Phenotypic traits, Body linear measurement*

INTRODUCTION
The increase in population and decrease in fertility rates of bulls are factors associated with limiting cattle production in developing countries including Nigeria (Faith et al., 2016). Bull fertility can be a major limiting factor in a breeding program. Infertility rates in bulls are estimated to be between 15 to 25 percent in the United States and Canada (Thundathil et al., 2016). The cattle production system in developing countries is not robust enough to overcome this challenge because the production system is smallholder operated and thrives on the use of low external input (Leroy et al., 2016). Hence, for cattle producers to be economical and contribute effectively to food security, this research focuses on the relationship between scrotal circumference, body condition score, age, and body measurement using regression analysis to determine if the breeding potentials of bulls under low external input production system support selection and determining the potential bulls to be used in reproduction programme.
The low external input production system of cattle is described with poor availability of quality pasture,

veterinary services, and indiscriminate use of drugs and vaccines; this is because most farmers often buy drugs at local markets from unskilled traders and majorly the efficiency of these therapeutic agents are erratic (Vaarst and Alrøe, 2012). Therefore, the primary aims of low external input operations are herd survival and sustained productivity to generate income for the provision of off-farm basic needs of the household (Thundathil et al., 2016). The evaluation of bull for breeding soundness is a vital aspect of reproductive management practice to exploit the maximum genetic potential in any livestock industry there is utmost need to assess the male (Asmare et al., 2013).

Sperm production is related to testicular development as shown by a positive correlation between testicular weight, sperm production and gonadal and extragonadal sperm reserves (Ommati et al., 2022). The heavier and larger the testes amount to the rate of sperm production. Testicular weight provided an accurate amount of the sperm-producing parenchyma in the testis of bulls (Ommati et al., 2022). The testicular weight was greater in certain breeds of animals with higher ovulation (Waqas et al., 2019). Since the testis weight cannot be measured directly in the male, scrotum circumference was found to be significantly correlated to testis weight (Chacko & Schneider, 2019), the circuitous technique of measuring scrotal circumference has been exploited. Scrotal circumference dimensions are well correlated with paired testis weight, which in turn is directly and extremely correlated with daily sperm production and high semen quality traits (Waqas et al., 2019).

A body condition score is an essential measure of the fitness of an animal for evaluating the body reserves in an animal (Silva et al., 2021). Condition score uses physical palpation of tissues cover over the backbone and the short ribs behind the last long ribs. Body condition score is not exercised on the farms, and its relationship with body weight and testicular traits is not known (Tyasi, 2022).

METHODOLOGY

The current study was conducted in two different agroecological zones of Nigeria namely; the southern guinea savanna and the Derived guinea savanna. The southern guinea savanna is characterized by the annual rainfall of 1140mm – 1520mm (March – November) while the derived savanna receives an average of 1275 – 1030 mm rainfall per annum. Qualitative data was collected by exploring both individual questionnaires and Focus group discussions (FGD) among the local farmers on the farms. In the FGD conducted, 6 – 10 farmers were interviewed as described by Nabukenya et al. (2014). Fifty farmers were interviewed and four FGD were conducted in both agroecological zones. Indigenous bulls kept raised on a low external input system of production of age 2 – 5 years were used as experimental animals. Body length (BL) was measured diagonally across the body of the bull using a flexible measuring tape in centimetres. Heart Girth (HG) measurement was taken by measuring the circumference of the girth using a measuring tape in centimetres. Scrotal circumference (SC) was measured with a flexible tape in centimetres (cm) at the maximum point of dimension round the pendulous scrotum after pushing the testes firmly into the scrotal sac as described by Nwachi Akpa (2013). Body condition score (BCS) was taken on the bulls based on the procedure for body condition scoring recommended by Soares & Dryden (2011) which states that a range of 1-9 scores.

Data

Data were collected from 80 indigenous cattle comprising 40 bulls and 40 cows from the southern guinea savanna and derived savanna using a measuring tape for phenotypic measurements. Statistical Package for Social Sciences version 26.0 (IBM SPSS, 2019) was used for data analysis. Descriptive analysis (average mean, standard deviation, standard error of mean and coefficient of variance) were calculated for the traits measured in both bulls and cows. Pearson's correlation was used to calculate the relationship between live weight, heart girth, body length, and body condition score in cows but with testis circumference in bulls.

Descriptive Data

Data from the measured traits were used in predictive modelling. Multiple regression was used to develop different models for selection of bulls and cows for breeding program using $y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + \ldots.. b_nX_n$, Where y is the dependent variable, a is the regression intercept, $b_1 - b_n$ is the coefficients of regression, and $X_1 - X_n$ is the independent variables.

The following models were developed for bulls:

Testis Circumference = -71.84 + 2.32Age + 2.73Hearth Girth + 0.03Body Length – 0.32Live Weight + 2.56Body Condition Score

BCS = 9.96 – 0.57Age – 0.45HG + 0.08BL + 0.05LW + 0.21TC

LW = -356.15 + 2.10Age + 8.58HG + 2.68BL – 1.31TC + 2.68BCS

HG = 41.25 + 0.72Age – 0.31BL + 0.12LW + 0.15TC – 0.30BCS

BL = 77.25 + 0.72Age – 1.19HG + 0.14LW + 0.01TC + 0.21BCS

Age = 0.11 – 0.27HG + 0.19BL + 0.03LW + 0.14TC – 0.40BCS

Models developed for cows are as follows:

LW = -546.55 – 0.44Age + 9.60HG + 5.92BL – 6.14BCS – 1.44Age at Puberty + 0Age at first calving

BCS = -24.88 – 0.03Age + 0.50HG + 0.19BL + 1.30Age at puberty + 0Age at first calving – 0.04LW

Age = 4.78 + 0.19HG – 0.21BL + 0.26Age at puberty + 0Age at first calving – 0.01LW – 0.05BCS

HG = 53.60 – 0.51BL – 0.06Age at puberty + 0Age at first calving + 0.01LW + 0.76BCS + 0.19BCS

BL = 73.27 + 0.09Age at puberty + 0Age at first calving + 0.11LW + 0.53BCS – 0.37Age – 0.96HG

Age at Puberty = - 0.75 + 1Age at first calving – 1.4LW + 2.37BCS + 4.39Age + .19HG + 7.76BL

Age at first calving = 0.75 +1.22LW + 4.73BCS – 3.2Age – 1.07HG -7.76BL + 1.00Age at puberty

Where TC is testis circumference, LW is live weight, BCS is body condition score, HG is heart girth and BL is body length.

RESULTS

Table I shows the phenotypic correlation between LW, BCS and body linear measurements of indigenous bulls while Table II shows the correlation between LW, BCS and phenotypic body measurements of cows. The result indicated that HG had a high positive correlation ($p < 0.01$) with LW. Also, the result presents a positive statistical correlation ($p < 0.05$) between TC and BCS.

Table I. Phenotypic correlation between live weight, body condition score, testis circumference and body measurements of bulls

Traits	LW	HG	BL	BCS	TC
LW	-				
HG	0.99**	-			
BL	0.35	0.24	-		
BCS	0.37	0.38	0.15	-	
TC	0.04	0.05	-0.30	0.54*	-

**, Significant at P < 0.01; LW, Live weight (kg); *, Significant at P < 0.05; HG, Heart girth (cm); BL, Body length; BCS, Body condition score; TC, Testis circumference (cm).

Table II indicated a high positively statistical correlation ($p < 0.01$) between LW and HG, BL and BCS. The result also shows that there is a high correlation ($p < 0.01$) between BCS and HG. Lastly, BL had a positive correlation ($p < 0.05$) with HG.

Table II. Phenotypic correlation between live weight, body condition score and body measurements of cows

Traits	LW	HG	BL	BCS
LW	-			
HG	0.97**	-		
BL	0.69**	0.52*	-	
BCS	0.60**	0.72**	0.17	-

**, Significant at P < 0.01; LW, Live weight (kg); *, Significant at P < 0.05; HG, Heart girth (cm); BL, Body length; BCS, Body condition score.

Discussion

Cattle are mostly reared for meat, milk and farm power, and they play a worthy role in food security, and socio-economic activities in the lives of farmers and masses (Rehman et al., 2017). This study was conducted to build models and examine the relationship between LW, Body linear measurements in cows and testicular measurement traits in bulls as a result of breeding value dependency on those traits. Our result obtained from the study shows that there is a highly remarkable relationship between LW and HG because LW can be estimated more accurately as reported by Tyasi (2022) . Similarly, there is a significant relationship between BCS and the TC of the bulls. A similar report was reported by Tyasi (2022) in Dorper Sheep. Faith et al. (2016) reported that LW had a significant correlation with SC. Tariq & Bajwa (2012) also reported that BCS had a remarkable correlation with the LW of indigenous Mengali sheep of Pakistan. The variation might be due to age, breed, and management differences. Faith et al.(2016); Tyasi (2022) reported that rams with larger testicular measurement traits might have larger LW. The results also showed that there remarkable correlation between LW, BCS, and body measurements. This study suggests that TC can be used to improve the BCS in bulls while the increase in LW and HG can be used in improving the BCS in cows. Phenotypic variations in traits of animals are due to joint effects of genetics and environment, and genetic and environmental factors independently (Barghi et al., 2020).

CONCLUSION

Pearson's correlation results suggest that Body Condition Score are positively and highlycorrelation with testis circumference. Correlation findings suggested that increasing testis circumference might improve the body condition score while the body condition score might improve the live weight of the bulls. The results also suggested that the body condition score is highly correlated to the heart girth, and live weight of the cows and this denotes that an increase in live weight improves the body condition score, heart girth and body length. Therefore, the findings of this study might be useful in the selection of bulls and cows for breeding purposes.

References

Asmare, K., Megersa, B., Denbarga, Y., Abebe, G., Taye, A., Bekele, J., Bekele, T., Gelaye, E., Zewdu, E., Agonafir, A., Ayelet, G., & Skjerve, E. (2013). A study on seroprevalence of caprine brucellosis under three livestock production systems in southern and central Ethiopia. *Tropical Animal Health and Production*, *45*(2), 555–560. https://doi.org/10.1007/s11250-012-0258-2

Barghi, N., Hermisson, J., & Schlötterer, C. (2020). Polygenic adaptation: a unifying framework to understand positive selection. *Nature Reviews Genetics*, *21*(12), 769–781. https://doi.org/10.1038/s41576-020-0250-z

Chacko, C. T., & Schneider, F. (2019). *Breeding Services for Small Dairy Farmers*. CRC Press. https://doi.org/10.1201/9780429187896

Faith, E. A., Yakubu, A., Ayodele, O. O., & Usman. (2016). *Phenotypic Relationship Between Body Weight, Body Condition Score and Testicular Traits of Yankasa Rams*. www.patnsukjournal.net/currentissue

Leroy, G., Baumung, R., Boettcher, P., Scherf, B., & Hoffmann, I. (2016). Review: Sustainability of crossbreeding in developing countries; definitely not like crossing a meadow…. *Animal*, *10*(2), 262–273. https://doi.org/10.1017/S175173111500213X

Nabukenya, I., Rubaire-Akiiki, C., Olila, D., Ikwap, K., & Höglund, J. (2014). Ethnopharmacological practices by livestock farmers in Uganda: Survey experiences from Mpigi and Gulu districts. *Journal of Ethnobiology and Ethnomedicine*, *10*(1), 9. https://doi.org/10.1186/1746-4269-10-9

Nwachi Akpa, G. (2013). Animal science research View project Relationships between Semen Cation Concentrations, Semen Characteristics, Testicular Measurements and Body Conformation Traits in Red Sokoto Goat. In *Nature and Science* (Vol. 11, Issue 7). http://www.sciencepub.net/naturehttp://www.sciencepub.net/nature

Ommati, M. M., Li, H., Jamshidzadeh, A., Khoshghadam, F., Retana-Márquez, S., Lu, Y., Farshad, O., Nategh Ahmadi, M. H., Gholami, A., & Heidari, R. (2022). The crucial role of oxidative stress in non-alcoholic fatty liver disease-induced male reproductive toxicity: the ameliorative effects of Iranian indigenous probiotics. *Naunyn-Schmiedeberg's Archives of Pharmacology*, *395*(2), 247–265. https://doi.org/10.1007/s00210-021-02177-0

Rehman, A., Jingdong, L., Chandio, A. A., & Hussain, I. (2017). Livestock production and population census in Pakistan: Determining their relationship with agricultural GDP using econometric analysis. *Information Processing in Agriculture*, *4*(2), 168–177. https://doi.org/10.1016/j.inpa.2017.03.002

Silva, S., Araujo, J., Guedes, C., Silva, F., Almeida, M., & Cerqueira, J. (2021). Precision Technologies to Address Dairy Cattle Welfare: Focus on Lameness, Mastitis and Body Condition. *Animals*, *11*(8), 2253. https://doi.org/10.3390/ani11082253

Soares, F. S., & Dryden, G. McL. (2011). A Body Condition Scoring System for Bali Cattle. *Asian-Australasian Journal of Animal Sciences*, *24*(11), 1587–1594.

https://doi.org/10.5713/ajas.2011.11070

SPSS, 2019. Statistical Packages for Social Sciences for Windows: Base System User's Guide, release 26.0. Inc. Chicago, USA

Tariq, M. M., & Bajwa, M. A. (2012). Prediction of Body Weight from Testicular and Morphological Characteristics in Indigenous Mengali Sheep of Pakistan using Factor Analysis Scores in Multiple Linear Regression Analy Static Analysis of Web Applications View project Disaster Management View project. In *Article in International Journal of Agriculture and Biology*. http://www.fspublishers.org

Thundathil, J. C., Dance, A. L., & Kastelic, J. P. (2016). Fertility management of bulls to improve beef cattle productivity. *Theriogenology*, *86*(1), 397–405. https://doi.org/10.1016/j.theriogenology.2016.04.054

Tyasi, T. L. (2022). Phenotypic Relationship between Body Weight, Body Condition Score and Testicular Measurement Traits in Dorper Rams Raised in Syferkuil Farm, Limpopo Province, South Africa. *Pakistan Journal of Zoology*. https://doi.org/10.17582/journal.pjz/20210508160534

Vaarst, M., & Alrøe, H. F. (2012). Concepts of Animal Health and Welfare in Organic Livestock Systems. *Journal of Agricultural and Environmental Ethics*, *25*(3), 333–347. https://doi.org/10.1007/s10806-011-9314-6

Waqas, M. S., Ciccarelli, M., Oatley, M. J., Kaucher, A. v, Tibary, A., & Oatley, J. M. (2019). Enhanced sperm production in bulls following transient induction of hypothyroidism during prepubertal development. *Journal of Animal Science*, *97*(4), 1468–1477. https://doi.org/10.1093/jas/sky480

56 ASSESSMENT OF MATING PROFILE OF RED SOKOTO BUCKS ADMINISTERED VARYING DOSAGE OF ETHANOLIC EXTRACT OF TIGER NUT (cyperus esculentus)

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Abstract
Tiger nut (Cyperus esculentus) is consumed by humans and livestock. It also has many medicinal uses such as aphrodisiac properties. There is an incidence of sexual incompetence, erectile dysfunction, premature ejaculation and reduced libido on the rise. . Hence, this study seeks to assess or evaluates the effect of ethanolic extract of tiger nut on mating traits or profiles of red Sokoto bucks. Consequently, the effect of ethanolic extract of tiger nut on mating profiles to determine the sexual performance efficiency in male Red Sokoto bucks were investigated. Nine (9) healthy red Sokoto bucks were divided in to three treatments of three bucks per treatment in a complete randomized design. The bucks were treated with ethanolic extract of tiger nut (EETN) at 0ml, 5ml and 10ml respectively for a period of 90 days (12wks). After which the bucks were allowed to mate with the does for the observation of sexual traits by introducing number of equivalents does (n=18). The mating parameters either decreased or increased in a EETN dose dependent manner; without traces of weaknesses or reduced penile reflexes and a higher significance function ($p<0.05$) was observed in group C. In conclusion EETN has a strong lasting potential on mating profile in male goats (buck) can be used as a fertility booster

KEY WORDS: *Cyperus esculentus*, Bucks, Aphrodisiac, libido, Erectile dysfunction.

Materials and Method

The study was carried out at National Agricultural Extension Research and liaison Services, North central Zonal office, Baddegi , Niger state from April to June 2021. The state falls within the northern guinea savanna zone of Nigeria and is about 430m above the sea level. It is located between latitude 9^0 31' and 9^0 42' North and longitudes 6^0 29' and 6^0 41' East of equator. Niger state has two distinct climates, the dry season from (November to March). And the rainy season from (April – October) with mean annual rain fall between 1,000mm to 1,500 mm, with an average highest temperature in the month of March and lowest temperature in the month of August. The mean annual temperature is between 21 to 36.5^0c. The relative humidity observed in the state varied from 15-65% - 26.39% (NASDP,2020).

Collection of plant materials: Fresh tiger nut (*Cyperus esculentus*) were purchased from Kure Ultra – modern market, Minna, Niger state, Nigeria. The fresh tiger nut were screened and washed to remove sand and debris, sun dried and pulverized in to fine powder using pestle and mortar in line with (Ekalou *et al*.,2015). The tiger nut powder was soaked in 85% ethanol solution for 48 hours, mixed every 6 hours and then filtered using the muslin cloth. The filtrate was evaporated using rotatory evaporator. This was also to remove excess alcohol from the extract before finally kept in refrigerator for use throughout the experiment.

Source and Management of Experimental Animals:

Nine (9) red Sokoto bucks within the age range of 5-6 months were used for this study. The does were purchased from within Niger state principally from goat market at Izom. The goats were allowed to acclimatize for a period of two (2) weeks.. During acclimatization, the goats were administered with Ivomectin®; a broad spectrum anti-parasitic drug, to remove both ecto and endo parasites. Broad spectrum anti-biotic (20 % Oxyteracycline manufactured by Heibei huarun pharmacy co Ltd, china), Penstrep (manufactured by Kepro, Holland), and some other drugs were administered when necessary to keep the animals in good health. Feed and water were provided ad libitum.

Experimental Design and Procedure

The nine (9) bucks were randomly divided in to four treatments in a completely randomized design. The animals were allowed to acclimatize for the period of two weeks before the commencement of the research. The bucks in control and treatment groups were treated with 0ml, 5ml and 10ml of tiger nut extract per kilogram body weight thrice (3) in a week respectively through oral gavage throughout the experiment. After 4week (30 days) of experiment , mount latency, mount frequency , intromission frequency, ejaculatory latency , post –ejaculatory interval, ejaculation frequency , intromission latency, inter-intromission interval were keenly observed after introducing (does). Adienbo *et al.,* (2013) method for determining sexual characteristics in animals were adopted for mating profile in this present study.

Data analysis.

Data collected were subjected to the analysis of Variance (ANOVA) Using SAS statistical package (SAS, 2006). Duncan Multiple Range Test was employed to separate the treatment means.

Results

The mating characteristics presented in Table 1.1 showed existence of significant differences ($p<0.05$) among the treated and control group in most of the parameters assessed. Among the parameters measured are mount latency (ML), mount frequency (MF), intromission latency (IL), intromission frequency (IF), ejaculation latency (EL), ejaculatory frequency (EF), post –ejaculatory interval (PEI),inter-intromission interval (III) and intromission frequency. The bucks treated or administered 5mg and 10 mg extract showed significantly ($p<0.05$) higher mating characteristic than the treatment one (control). The ejaculatory frequency and post-ejaculatory frequency was statistically ($p<0.05$) higher in T_3 and T_2 respectively but differed statistically from $T_{1.}$ Inter-intromission interval was higher in T_3 but showed no significant ($p>0.05$) difference from T_2 which differ significantly from $T_{1.}$ The intromission were statistically ($p>0.05$) equal.

TABLE 1: Mating profiles in bucks administered varying dosage of ethanolic extract of tiger nut for 90 days

PROFILE	CONTROL	5mg	10mg	SEM
Mount latency (ML) sec.	183.16 ± 0.2^{c}	406.15 ± 0.2^{b}	791.27 ± 0.3^{a}	0.34
Mount frequency (MF)	2.32 ± 0.9^{c}	3.71 ± 0.3^{b}	5.89 ± 0.3^{a}	0.23
Intromission latency (IL) sec.	114.55 ± 4.1^{a}	224.80 ± 2.7^{b}	322.23 ± 1.1^{a}	0.25
Intromission frequency (IF)	11.06 ± 0.5^{c}	31.93 ± 0.6^{b}	42.02 ± 0.4^{a}	0.26
Ejaculation latency (EL) sec.	345.37 ± 3.1^{bc}	434.90 ± 3.7^{ab}	541.22 ± 2.1^{a}	0.42
Ejaculatory frequency (EF)	1.75 ± 0.4^{c}	2.75 ± 0.4^{b}	3.05 ± 0.9^{a}	0.31
Post – ejaculatory interval (PEI) sec.	295.62 ± 2.3^{c}	385.50 ± 1.1^{ab}	485.12 ± 1.3^{a}	1.23
Inter – intromission interval (III) sec.	34.58 ± 0.2^{bc}	43.19 ± 0.6^{ab}	54.11 ± 2.2^{a}	0.32
Intromission ratio (I/R)	2.70 ± 0.3^{a}	3.79 ± 0.5^{a}	4.05 ± 0.1^{a}	0.27

abc means within a row having different superscripts differed significantly ($p<0.05$).

Discussion

In this study, we defined each parameter for a mating profile to enable the understanding of the terms that constitutes sexual traits in bucks (Anisa *et al*. 2015). The mount latency (ML) is the interval from the introduction of does to the first mount. Mount frequency (MF) showed the number of mounts prior to an ejaculation while inter-intromission interval (III) is the average intromission between succeeding intromissions. These observations were significantly demonstrated by the ethanolic extract of tiger nut especially on the 30 day of administration as compared to the control (1-3). This proofs that ethanolic extract of tiger nut has aphrodisiacs potentials (Ekaluo, *et al*., 2015), which emphasized the need for reduced time of ML, IL, PEI, and III as an indication of power, potency , improved sex drive and vigour in sexuality. These findings support the claim in which reduced ML, IL, PEI, and III were observed to be a reflection of sexual inspiration in animals (Fourche *et al*., 2015).

This also support the findings of Anisa *et al*., (2020) who opined that methanolic extract of tiger nut is a highly significant($p< 0.01$) increase in MF, EL, IF, and IR and that a rise indicates that tiger nut extract is capable of causing improved sexuality in treated bucks.. This finding is further buttressed by the report of Fouche *et al*. (2015) who stated that MF is an important measure of both libido and potency and as such an elevated value is indicative of a sustained increase in sexual stimulus or activities and aphrodisiac property in a plant. While there is an affirmation that elevated MF is believed to be an important index of sexual stimulus ,efficacy of erection and coordination(Prakash *et al* ., 2015) while intromission frequency (IF) observed as the number of vaginal penetration until there is a discharge, which differs from intromission latency (IL) that relates to the recorded time from when a does is introduced in to the investigation pen to the first vaginal penetration (Anisa *et al* .,2020).

A delayed penetration is an indication of poor sexual performance, viability, and reduced libido. This findings revealed a dosages dependent in intromission frequency (IF) from the ethanolic extract and a reduction in IL in a similar manner as reported by Anisa *et al* ., (2020). This research agrees with an earlier report by Anisa *et al*., (2020) who opined that medicinal crops with possible potentials to improve sexual arousal, sexual stimulus ought to result in a significant increase in IF and decrease IL, which are both indicative of aphrodisiac activities. This agrees with Sharma et al., (2010) who reported that a significant rise in the sum of intromission frequency (IF) is an indication of erectile efficiencies ,penile positioning and the perfect manner at which ejaculatory reflexes are coordinated after activation. The improvement observed in sex drive, sexual ability, vigour, strength and erectile viability was further corroborated by increase intromission ration (I/R) across all the treatment groups compared to control. This supported the findings of Allouh *et al*., (2015) who defined the intromission ration as the extent of successful vaginal penetration , which is calculated as intromission frequency (IF)/ (mount frequency +intromission frequency). However, the degree of efficiency or improvement is best shown in treatment two (2) and three (3) as compared to treatment 1(control).

The intensity of sexual libido increases along line of doses which agrees with Adama *et al*., (2020) who lamented that this increasement in sexual urge appetite was as a result of administered extract. Other parameters like ejaculatory frequency (EF), which is the number of discharges observed from the period of mount to a specified time frame (40 minutes). Ejaculatory latency (EL) being the time between the first intromission and the first discharge. Post ejaculatory interval (PEI) as the time between a discharge following the vaginal penetration. Anderson (2011) argued that the ability to engage in the act of sexual performance depend on the erectile function thus it can be observed that erectile dysfunction, affect the entire sex life even when there is a very strong sexual urge. The above research reveals adequate penile erection and penetration was more pronounced in bucks in treatment two and three but significantly higher ($p<0.05$) in treatment three which agrees with Adama *et al*. (2020); in which erection was observed in all the treated rabbits (2020) in a doses dependent manners.

Conclusion

From the results of this research study, it can be concluded that ethanolic extract of tiger nut (EETN) has a potential for the reactivation of sexual dysfunction and impotency in a dosage dependent manner. EETN can be used as a fertility booster and in attenuating sperm. It is a promising aphrodisiac with health benefits for small ruminants. Thus, it could be used to safely replace synthetic drugs or hormones and about 10mg daily is recommended

References

Adama, J. Y., Kudu, Y . S. and Usman, A. 2020. Reproductive Performance of Rabbits administered graded doses of tiger nut (Cyperus esculentus) extracts. *Nigerian Journal of Agriculture and Forestry*, 7(1), 82-88

Abedi, A., karimian, S . M., Parvez, M., Muhammad. P. and Roudsari , H.R.S. 2014. Effects of aqueos extract of *Phoenix dactylifera* pollen on dopamine system of nucleus accumbency in male rats. *Neuroscience* and *Medicine* 5(3) 49-59.

Adienbo, O. M., Nwafor, A. and Ronami, S. O. 2013. Effects of Hydro methanolic extract of *Xylopia aethopica* on sexual behavior jn male Wistar rats.

International Journal of Advanced Biological Research, 1(9):1078-1085.

Allouh, M.Z., Daradka. H. M and Abu-Ghaida, J. H. 2015. Influence of Cyperus esculentus Tubers (Tiger nut) on male rat copulatory behavior. BMC complementary and Alternative Medicine, doi:10.1186/s12906-015-0851-9.

Anderson, K. E. 2011. Mechanism of penile erection and basis for pharmacological treatment of erectile dysfunction. *Pharmacology Review*, 63(4):811-859.

Anisa, A., Omar., B . E., Osama, E . B. and Salam, A. B. 2020. Aqueos extract of Cyperus esculentus L (Cypereceae) enhances libido and spermatogenesis in male Wistar rats. *Tropical Journal* of Natural Product Research, 2(11):471-475.

Ekaluo , U. B, Ikpeme, E.V., Ibiang , Y .B and Amacchina, O. S. 2013. Attenuating role of Vitamin on Sperm toxicity induced by caffeine in albino rats. *Journal* of Medical Science, 13:3-7

Fouche, G., Afolayan ., A .J., Mintola , O . A., Khorombi , T .E. and Senabe, J . 2015. Effect of the aqueous extract of the aerial parts of Mansonia angustifolia E. Mey. EX A. Rich, on the sexual behavior of male Wistar rats.BMC complementary and Alternative Medicine,15:343-353.

Prakash. R., Dheeraj. R., Muralitharan, P., Karchikeyan, K., Vijayakumar, R. and Prabu, T. P. 2015. Aphrodisiac activity of cocoa nucifera 67. attenuates sulphate induced infertility in male rats.*PTB Reports*, 1(2*):*62

Sharma, V., Thakur, M., Chauhan, N. S and Dixit, V. K. 2010. Effects of petroleum ether extract of Anacyclus pyrethrum DC on sexual behavior of male rats. *Journal of Chinese integrated medicine*, 8(1):767-773.

57 EFFECTS OF CRUDE OR SYNTHETIC ENZYMES ON THE DIGESTIBILITY OF BROILER FINISHER CHICKENS FED GROUNDNUT-COWPEA SHELL BASED DIETS

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Abstract
A 28 day evaluation of the effect of crude or synthetic enzymes on the growth performance of broiler chickens (Cobb 500) fed groundnut-cowpea shells (GCSM) based diet was conducted using a total of two hundred and forty birds randomly allotted to five dietary treatments replicated four times with 12 birds each in a Completely Randomized Design (CRD). Diet T1 had 0% GCSM: 0%dried rumen content (DRC), 0% mushroom and 0ppm synthetic enzyme and served as the control; diet T2 had 25% GCSM, 0% DRC, 0% mushroom, and 0ppm enzyme; diet T3 contained 25% GCSM, 5% DRC, 0% mushroom and 0ppm synthetic enzyme; Diet T4 contained 25% GCSM, 5% mushroom 0% DRC and 0ppm synthetic enzyme and diet T5 had 25% inclusion of GCSM, 200ppm synthetic enzyme, 0% DRC and 0% mushroom. Feed and water were provided ad-libitum. The nutrient digestibility for finisher proved that Prude protein (CP), Nitrogen Free Extract (NFE) and Dry Matter (DM) are not significant (P>0.05), the significant (P<0.05) values are in Ether Extract (EE), Ash and Crude Fibre (CF).

Keywords: Digestibility, Broiler finisher, crude enzyme, Synthetic enzyme.

DRSCRIPTION OF PROBLEM

Copious efforts have been put in place to make food available for global populace particularly the utilization of farm by-products to feed livestock. It was observed that undernourishment is more pronounced in underdeveloped nations (FAO, 2008) and this has always led to reappearance of interest in the sourcing of less expensive alternative feed ingredients as replacement for the more expensive conventional ones in livestock feed formulation. The aim is to increase the availability and affordability of animal products in order to alleviate universal food predicament.
Alternative feed ingredients also referred to as non-conventional feedstuffs are mostly agro-industrial by-products. The importance of agro-industrial by-products and the so-called "wastes" in meeting the energy and protein needs of farm animals is best appreciated when it is realized that feeding alone accounts for about 60 to 85% of the cost of intensively reared mono-gastric animals (Sanni and Ogundipe, 2005).
There was an observation by Alu (2010) that says in order to enhance the utilization of agro-waste products in poultry and monogastric diets, the high fiber contents must be broken down and its nutrient composition improved through processing. One of the ways of accomplishing this is through the using of enzyme supplementation or fermentation. McAllister *et al.* (2001) described the enzymes as naturally occurring biocatalysts which are produced by living cells to bring about specific biochemical reactions.

Materials and Methods

Study area

The experiment was carried out at IBAS Poultry Farm Ltd Keffi, Nasarawa State. Keffi is located on Latitude $8^0$51 and $8^0$50 north of the equator and Longitude $7^0$50 and $7^0$51 east of the Greenwich meridian.

The town had an average altitude of 850m beyond the sea level. The minimum yearly rainfall of the area is 1100mm and maximum of about 2000mm. (Lyam, 20007).

Experimental diets

Five different experimental diets: T1, T2, T3, T4 and T5 were compounded to be isocaloric (3000 kcal/kg ME) and isonitrogenous (18%CP) for finisher chicks (Table 1)

Table 1: Gross composition of experimental diets of broiler chicks (Finisher)

Ingredients	T1 0G, 0D 0M+0S	T2 25G, 0D, 0M+0S	T3 25G, 5D, 0M+0S	T4 25G, 0D, 5M+0S	T5 0G, 0D, 0M+200S
Maize (%)	32.00	37.00	33.00	34.25	37.00
Soya bean (Full fat) (%)	17.00	20.00	23.00	23.00	20.00
Groundnut cake (%)	16.00	5.00	3.00	1.75	5.00
Maize bran (%)	16.00	0.00	0.00	0.00	0.00
Rice bran (%)	10.00	2.00	0.00	0.00	2.00
Groundnut shells (%)	0.00	15.00	15.00	15.00	15.00
Cowpeas shells (%)	0.00	10.00	10.00	10.00	10.00
Bone meal (%)	2.00	0.00	0.00	0.00	0.00
Blood meal (%)	1.00	5.00	5.00	5.00	5.00
Salt (%)	0.25	0.25	0.25	0.25	0.25
Palm oil (%)	5.00	5.00	5.00	5.00	5.00
Lysine (%)	0.25	0.25	0.25	0.25	0.25
Methionine (%)	0.25	0.25	0.25	0.25	0.25
Premix (%)	0.25	0.25	0.25	0.25	0.25
Dried Rumen Content (DRC) (%)	0.00	0.00	5.00	0.00	0.00
Mushroom (%)	0.00	0.00	0.00	5.00	0.00
Enzyme	0.00	0.00	0.00	0.00	++
Toxin binder	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100
Nutrient and energy composition					
Energy kcal/kg (ME)	3090.89	3009.03	2992.04	2964.45	3009.03
Crude protein	20.49	20.07	20.16	20.08	20.07
Crude fibre	4.22	5.14	5.45	8.24	9.14
Ether extract (%)	8.53	10.89	11.702	10.89	10.98
Ash (%)	2.99	3.26	3.29	3.01	2.99
Calcium	1.11	0.42	0.44	0.52	0.42
Phosphorus	0,81	0.36	0.34	0.46	0.36
Lysine (%)	1.12	1.27	1.28	1.27	1.27
Methionine (%)	0.51	0.54	0.53	0.53	0.54

G= %Groundnut cowpea shell meal M=%Mushroom, S=ppm Synthetic enzyme, D=%Dried rumen content

. Diet T1 which did not contain Groundnut-cowpea shell meal (GCSM): Dried Rumen Content (DRC), mushroom and enzyme and served as control. Diet T2 had 25% GCSM, no DRC, mushroom, and enzyme, Diet T3 contained 25% GCSM, 5% DRC, mushroom and enzyme were not included also diet T4 contained 25% GCSM, 5% mushroom and none inclusion of DRC and enzyme, and diet T5 had 25% inclusion of GCSM, 200 ppm Quantum blue®; DRC and mushroom were not included. Broiler finisher chickens were fed with experimental diets for 28 days.

Collection and processing of experimental materials

The cowpea and groundnut shells were collected from the rural farmers in Kokona Local Government Area of Nasarawa State, Nigeria. The cowpea and groundnut shells were milled into powder to form a meal using a locally made miller machine (unbranded) and sun-dried at 35^{o}C for 5 hours as recommended by Ogbe and George (2012). Mushrooms were collected from the farmers in Kokona Local Government Area, Nasarawa State, and milled into powder form using pestle and mortar manually.

The rumen content was collected from the Keffi abattoir in Nasarawa state and sun dried for 3 days. The sundried material was milled using a hummer mill to produce finely ground dried rumen content meal. The Quantum blue® which was referred as synthetic enzyme was purchased from a registered dealer of agro industrial products known as Global Feeds Ltd located at New Nyanya, Karu LGA, Nasarawa State.

Experimental birds, management and design

Two hundred and forty (240) unsexed broiler chickens (Cobb 500 Strain) were used and their initial body weight was taken. The birds were reared in a deep litter system into five different compartments separated from each other by wire-mesh and was supported with wooden frame-work. They were provided with 200 watt bulbs to supply light and heat through electricity. Feed and water was provided to the birds throughout the experiment (*ad libitum)*, all the management routine practices were strictly adhered to for ultimate performance. The design for the research was Completely Randomized Design (CRD) and the birds were distributed randomly to five treatments at the rate of 12 birds per replicate. Each treatment was replicated four times.

Digestibility trial

Samples of the feaces were collected for a period of seven (7) days for finisher stage. Two birds per replicate were used for the nutrient digestibility trial and the feaces collected were weighed and dried in an oven at the temperature of 60^{0}c daily and dried samples were pooled together at the expiration of 7 days based on their treatment groups and grounded. Dried feaces samples were used to determine the proximate compositions as described by (AOAC, 2006).

Chemical analysis

Samples of the DRC, mushroom, groundnut and cowpea shells were taken to International Institute of Tropical Agriculture (IITA) Ibadan for proximate analysis using standard methods (AOAC, 2006). Nitrogen Free Extract (NFE) was calculated using the formula: NFE (%) = 100 – CP + CF + EE + Moisture + Ash. Metabolizable energy (ME) was calculated using Pauzenga Formula ME =37 x % CP + 81 x %EE + 35.5 x % NFE. (Pauzenga, 1985).

Table 2: Chemical composition of groundnut shells, cowpea shells, dried rumen content and mushroom

Nutrient	Groundnut shell	Cowpea shell	Dried Rumen Content	Mushroom *(G. lucidum)*
Crude protein (%)	5.43	19.82	9.25	16.07
Ether extract (%)	0.71	0.63	2.95	1.43
Crude fibre (%)	55.60	33.01	30.28	8.02
Ash (%)	3.17	4.11	11.41	9.01
Dry matter (%)	90.31	88.46	90.33	88.85
Nitrogen Free Extract (NFE) (%)	25.41	36.99	36.44	35.92

Statistical analysis The data obtained during the research were subjected to One Way Analysis of Variance (ANOVA) and significant means were separated using Duncan's Multiple Range Test (DMRT) (Duncan, 1955).

Results and Discussions

The effect of crude or synthetic enzymes on digestibility of broiler finisher chickens fed groundnut-cowpea shell based diet shown in Table 3. The digestibility of ether extract and crude fibre were significantly ($P<0.05$) depressed as the level of treatment increase in the diets. Birds fed the control diet had better ether extract digestibility of 89.44% whereas those fed the control T2 and T3 had better crude fibre digestibility of 39.04%, 40.45% and 40.63%, respectively. Ash digestibility was significantly ($P<0.05$) highest in birds fed diet T3 (52.75%). The significant increase in crude fibre in birds fed diet T3 may be attributed to the addition of crude enzyme. This observation is in agreement with the previous work of Alu *et al.* (2012) who investigated the growth and nutrient digestibility of groundnut shell meal based diet treated with alkali fed to broiler chickens and recorded a better crude fibre digestibility in all treatment diets compared to control.

Table 3: Effect of crude or synthetic enzyme on digestibility of broiler finisher fed groundnut-cowpea shells meal based diet

PARAMETERS	T1 0G, 0D, 0M+0S	T2 25G, 0D, 0M+0S	T3 25G, 5D, 0M+0S	T4 25G, 0D, 5M+0S	T5 0G, 0D, 0M+200S	SEM	LOS
NUTRIENT DIGESTIBILITY							
Crude protein	88.99	89.34	89.00	90.01	90.89	0.29	NS
Ether extract	89.44^{a}	87.41^{b}	86.37^{b}	86.47^{b}	86.87^{b}	0.41	*
Crude fibre	39.04^{a}	40.45^{a}	40.63^{a}	33.33^{c}	36.51^{b}	0.93	*
Ash	54.00^{b}	57.81^{a}	52.75^{bc}	50.29^{d}	51.36^{cd}	0.89	*
Nitrogen free extract	63.35	63.97	64.24	63.39	64.67	0.24	NS
Dry matter	68.40	68.18	68.28	68.45	69.24	0.19	NS

ab means on the same column having different superscript differ significantly ($p<0.05$); NS = not significantly different ($p>0.05$); SEM = standard error of mean; LOS = level of significant. %G= Groundnut cowpea shell meal %M=Mushroom, ppmS= Synthetic enzyme, %D=Dried rumen content

Conclusion

The result of this study has revealed that there was significant increase in crude fibre in birds fed diet T3 indicated that the addition of crude enzyme has improved the digestibility of the fibre content of the feed.

REFERENCES

Alu, S. E. (2010). Replacement of bone ash with eggshell meal on growth performance and carcass characteristics of broiler chickens. *International Journal of Food and Agricultural Research* 7 (1): 229-238.

Alu, S. E., Kaankuka, F. G., Carew S. N. and Tuleun C.D. (2012) Effects of Maxigrain® supplementation of sugarcane scrapping meal-based diets on the growth rate, Nutrient digestibility and cost implication of Japanese Quail (*Cortunix Cortunix Japonica*) Chicks. *International Journal of Engineering Research & Technology* Vol. 1 Issue 9, November- 2012 ISSN: 2278-0181

AOAC (2006). Official methods of analysis, Association of Official Analytical Chemists, Washington, D.C; USA.18th Edition.

Duncan, D.B. (1955). Multiple Ranges and Multiple F-Test Biometrics, 11:1-42.

FAO (2008). Food and Agriculture Organization of the United Nations. Prevalence of undernourishment in total population. Food Security Statistics. *http://www.fao.org/faostat/foodsecurity/index_en.htm*, Accessed on 24 December, 2008.

Lyam A., (2000). Nasarawa State. In: (Mamman A.B., Oyebanji J.O. & Peters S.W. (eds)), Nigeria: A people united, a future assured. Survey of States, Vol. 2, 2, Federal Ministry of Information, Abuja.

McAllister, T. A., A. N. Hristov, K. A. Beauchemin, L. M. Rode and K.-J. Cheng. (2001). Enzymes in ruminant diets. In: Enzymes in Farm Animal Nutrition (Ed. M. R. Bedford and G. G. Partridge). CABI Publishing, CAB International, UK. pp. 273-298

Ogbe, A.O. and George, G.A.L. (2012). Nutritional and anti-nutrient composition of melon husks: potential as feed ingredient in poultry diet. *Research Journal of Chemical Sciences, 2(2): 35-39.*

Pauzega, U. (1985). Feeding parentstock.*Zootocinca International*.Pp 22-25

Sanni, S. A. and Ogundipe, S. O (2005). Economics of some modules of poultry production in Kaduna State. *Nigerian Journal of Animal Production.* 23 (1):102- 107.

58 GROWTH PERFORMANCE AND EGG PRODUCTION OF JAPANESE QUAILS FED DIFFERENTLY PROCESSED (*Leucaena leucocephala*) BASED DIETS

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ABSTRACT

A study was conducted to determine the effects of differently processed Leucaena leucocephala based diets on the growth performance and egg production of Japanese quail birds. A total of 135 unsexed two week – old Japanese quail chicks were distributed into three equal groups. Group was the control while groups 2 and 3 contained 5 % boiled Leucaena leucocephala (BLL) and 5 % Roasted Leucaena leucocephala (RLL), respectively. Each group was replicated three times using completely randomized design. Data on growth performance at both starter and laying phases and egg production parameters were taken and subjected to one way analysis of variance. Where differences occurred at P<0.05 they were separated using Duncan multiple range test. After 12 weeks of feeding trial, results showed that dietary treatment had no (P>0.05) effect on all the growth parameters measured at the starter phase. However, at the laying phase, the total weight gain, total feed intake and daily feed intake were affected (P<0.05) by dietary treatments with birds on the control diet performing better than those on RLL. Dietary treatment had no (P>0.05) effect on all the egg production parameters measured. It can therefore be concluded, that boiled L. leucocephala at an inclusion level of 5 % is an ideal replacement for conventional feed sources in the diet of Japanese quails.

INTRODUCTION

The poultry industry has flourished as a result of rapid growth of the human population in developing and third-world countries, however, since the mid-eighties, poultry production has been on the decline mainly due to high cost of feed, drugs, disease, inadequate supply and poor quality of day-old chicks amongst other factors (Musa *et al*., 2008). As a result, people in most of these countries consume significantly less animal protein than recommended. Thus, there have been requests in emerging countries for a significant increase in animal protein consumption. Animal scientists in general, and nutritionists in particular, have focused on promoting the rearing of species that were formerly viewed as less significant in their drive to make animal protein more accessible and inexpensive to the average man. One of such poultry birds is the Japanese quail. They are fast growing birds that reach maturity between five and six weeks of age and lay their first eggs. In addition, the meat from the birds is lean and the egg is low in cholesterol, which is beneficial to public health. Like other poultry birds, feeding is a major challenge faced by quail farmers. Because of the seasonality of their production and competition for man and livestock consumption, their high inclusion rates translate into high feed costs. In light of this, any alternative crop that could be used to reduce the amount of these energy (maize) and protein (soya bean) sources in the diet will greatly lower the cost of producing feed for livestock, provided the crop is available in reasonable quantities, is inexpensive, easy to process, and potentially contributes as much, if not more, nutrients than the conventional ones in the diet. One of such is *L. leucocephala,* they are rich in crude protein and are readily available. This research work was aimed at determining the effect of differently processed *L. leucocephala* meal-based diet on the growth performance and egg quality of Japanese quails.

Materials and Methods

The research work was carried out at the Teaching and Research Farm at the Department of Animal Production Federal University of Technology, Bosso campus, Minna, Niger state, Nigeria. Minna lies between the Latitude 9 ^{0}23 ' to 6 ^{0}33 'E with annual rainfall of 1000 – 1500 mm and a temperature range 28 ^{0} – 30 ^{0}c. The mean annual rainfall varies from 1102.6 to 1361.7 mm. *L. leucocephala* pods was harvested within the Federal University of Technology, Gidan kwano Campus, Minna. The seeds were gathered and sorted to remove the dirt and stones. Maize, maize bran and salt were purchased from Kure Ultra-Modern Market, Minna. Groundnut cake, vitamin-premix, lysine, methionine, fishmeal and bone meal were purchased at Farida shop No. 7, Gidan Matasa, Bosso, Minna. A total of 135 two weeks old Japanese quails used for this study was purchased from Jigina Farms located in Bwari Area Council, Abuja.

Ingredients processing, experimental design and data collection

Five kg of *L. leucocephala* was roasted at 85 ^{0}c for 30 minutes using stove with iron pot mixed sand as described by Ojo *et al.* (2013). During roasting the seed was stirred continuously to ensure uniform roasting to prevent burning till they were brown. The seed was then spread out to cool after which they were milled using a hammer mill with the size of 3 mm and labeled roasted *Leucaena* seed meal (RSLM). Another five kg of each seed was subjected to boiling at 100 ^{0} C for 25 minutes as described by Jimoh *et al.* (2014) after which water was drained off by means of a 10 mm sieve and the seeds were sun – dried. The seeds were then milled using hammer mill and then sieved with a 3 mm sieve sized and labeled boiled *Leucaena* seed meal (BLSM). It was stored in an airtight container before use.

A total of 135 unsexed two week – old Japanese quail chicks were distributed into three equal groups. Group 1 was the control while groups 2 and 3 contained 5 % Boiled *L. leucocephala* (BLL) and 5 % Roasted *Leucaena leucocephala* (RLL), respectively. Each group was replicated three times using completely randomized design. On arrival, the birds were weighed and randomly assigned to their treatments, provided with water and feed *ad libitum.* Light was also provided for 18 hours. Diet containing 2700 kcal/kg ME and protein 22 and 18 %, were used at the starter and laying phases, respectively.

Data on body weight and feed intake were measured and used for calculating the body weight gain daily, weekly feed intake and feed conversion ratio using the procedure of Peter *et al*. (2006). The egg production performance characteristics determined included the hen-housed and hen-day egg production. All data collected were subjected to one way analysis of variance (ANOVA) using SAS (2015) at 5% probability level. Significantly different means were separated using Duncan Multiple Range Test (SAS, 2015).

RESULTS AND DISCUSSION

The results of the growth performance of quails fed processed *L. leucocephala* seed meal-based diets at the starter phase are presented in Table 1. The results showed that dietary treatment had no effect ($p>0.05$) on all parameters measured at the starter phase.

The results of the growth performance of quails fed processed *L. leucocephala* seed meal-based diets at the laying phase are presented in Table 2. The results showed that dietary treatments had effects ($p<0.05$) on the total weight gain, total feed intake and the daily feed intake of Japanese quails at laying phase. However, all other parameters (initial weight, final weight, daily weight gain and FCR) were not affected ($p>0.05$) by the dietary treatments.

Birds on Roasted *Leucaena leucocephala* (RLL) and Boiled *Leucaena leucocephala* (BLL) had similar ($p>0.05$) total weight gains, total feed intakes and daily feed intakes. There were no significant different ($p>0.05$) in the quails fed with control and BLL diets. However, birds on RLL had lower ($p<0.05$) total weight gain, total feed intake and daily feed intake than the birds on the control diet.

The results of egg production performance of the quails fed processed *L. leucocephala* seed meal-based diets at the laying phase are presented in Table 3. The results showed that dietary treatments had no effect ($p>0.05$) on all egg parameters (egg lay, hen day, hen house, haugh unit and egg weight) at the laying phase.

Roasted *L. leucocephala* diets exerted negative influence on the total weight gain at the laying phase. This could be because roasting destroyed some vital nutrients which were needed for growth in monogastric animals. Studies have shown that heat denatures protein in feed stuff, particularly, heat liable nutrients (OECD, 2001). This was in line with the report of Ari *et al*. (2012) when they evaluated the chemical composition and anti-nutritional factor levels of differently processed soyabeans. Their results showed that heat affected the amino acid profiles, indicating that proteins are less denatured by cooking processes compared to roasting processing method. Reduction in the anti-nutrients present in *L. leucocephala* was observed to be more efficient when processed by boiling (Agbo *et al*., 2017). The present finding were in line with the works of Wafar *et al*. (2016, 2018) that showed weight losses in broilers and rabbits when they were fed with roasted *mucana* and kapok seed meal diets, respectively. The similar results observed in the total weight gain in birds fed the control and boiled *L. leucocephala* seed meal diets at the laying phase could be an indication that the diets provided similar nutrients needed by the birds. This was in agreement with those of Akanji *et al*. (2016) that worked on the performance of broilers fed raw and processed cowpea diets. Wafar *et al*. (2016, 2018) also noted increases in the total weight gain for broilers and rabbits when fed diets containing boiled *mucana* and kapok seed meals, respectively. The reason for the dietary treatments having negligible effects on the egg production parameters observed in this study may imply that the requirements for egg production were adequate since there were no differences between the birds fed with treated and the control diets.

CONCLUSION

It could be concluded from the results of feeding differently processed *L. leucocephala* seed meal diets to Japanese quails that the dietary treatments had effect on the total weight gain, total feed intake and daily feed intake with boiling method and control exerting similar impact. However, roasted *L. leucocephala* feed meal diet had negative influence on these parameters at the laying phase. Also, the dietary treatments had no effects on the egg production parameters of Japanese quails. Thus, boiled *L. leucocephala* meal at an inclusion level of 5 % is recommended as a replacement for soya bean meal in the diet of Japanese quails.

Table 1 Growth Performance of Japanese quails fed Processed *Leucaena leucophala* seed meal Based Diets at the starter phase

Parameters	Control	BLL	RLL	SEM	P-value
Initial weight (g)	74.44	76.67	77.87	1.032	0.464
Final weight (g)	113.16	113.66	113.78	4.311	0.999
Weight gain (g)	38.72	36.99	36.00	4.074	0.972
Daily weight gain (g)	1.11	1.06	1.03	0.116	0.970
Total feed intake (g)	260.53	265.10	255.38	3.264	0.527
Daily feed intake (g)	6.20	6.32	6.08	0.780	0.528
FCR	5.69	6.91	7.00	0.861	0.830
Mortality (%)	0.00	0.33	0.67	0.167	0.296

Keys:-BLL-Boiled *Leucaena leucophala,* RLL -Roasted *Leucaena leucophala,* SEM -Standard Error Mean, FCR Feed Conversion Ratio

Table 2 Growth Performance of Japanese quails fed Processed *Leucaena leucophala* seed meal Based Diets at the Laying phase

Parameters	Control	BLL	RLL	SEM	p-value
Initial weight (g)	126.23	126.23	126.23	0.293	1.000
Final weight (g)	273.35	271.72	267.02	1.331	0.119
Total weight gain (g)	147.11^{a}	145.4^{ab}	140.78^{b}	1.270	0.046
Daily weight gain (g)	3.50	3.46	3.35	0.301	0.099
Total feed intake (g)	470.22^{a}	444.06^{ab}	417.29^{b}	8.915	0.019
Daily feed intake (g)	9.60^{a}	9.06a^{ab}	8.52^{b}	0.182	0.018
FCR	2.74	2.62	2.54	0.046	0.208

Keys:-BLL Boiled *Leucaena leucophala*, RLL Roasted *Leucaena leucophala*, SEM Standard Error Mean, FCR Feed Conversion Ratio

Table 3 Egg Production Parameters of Japanese quails fed Processed *L. leucocephala* seed meal Based Diets.

Parameters	Control	BLL	RLL	SEM	P-value
No. of egg lay	37.67	35.33	27.33	4.243	0.645
Hen Day	7.84	8.29	6.65	1.073	0.852
Hen House	5.55	5.56	5.67	0.955	0.999
Haugh unit	90.76	99.68	98.79	2.406	0.278
Egg weight	5.76	5.97	7.22	0.370	0.238

Keys:-BLL Boiled *Leucaena leucophala*, RLL Roasted *Leucaena leucophala*, SEM Standard Error mean,

REFERENCES

Agbo, A.N., Balogun, J.K., Oniye, S.J. & Auta, J. (2017). Effect of different processing methods on nutritional composition of *Leucaena leucocephala* (Lam De Wit) leaves as inclusion in Fish Feed. Journal Federal Department of Fisheries, Kaduna. Department of Biological Sciences, Ahamadu Bello University, Zaria.

Akanji, A. M., Fasina, O. E., Ogungbesan, A. M &Adeleke, G. A. (2016). Laying performance, Haematology and Serum Biochemical profile of the Hen fed unfermented and fermented African locust bean seed. *Agro-science Journal of Agriculture and Food Environment. Ext. 15(1):1-5.*

Ari, M.M., Ayanwale, B.A., Adama, T.Z. & Olatunji, E.A. (2012). Evaluation of the Chemical Composition and Anti Nutritional Factors (ANFs) Levels of Different Thermally Processed Soybeans. *Asian Journal of Agricultural Research 6: 91-98.*

Jimoh, W.A., Ajasin, F.O., Adebayo, M.D., Banjo, O.T., Rifhat, A.O. &Olawepo, K.D. (2014). Haematological changes in the blood of clariasgariepinus fed chrysophyllumalbidum seed meal replacing maize. *Journal of Fishries and Aquatic Science*.9,407-412.

Musa, U., Haruna, E. S., Qadeer, M.A., Edache, J.A *et al*., (2007). Effect of storage period and the hatchability performance of Japanese quail eggs *(Coturnixcoturnix japonica)*. *Nigeria Journal of Animal Production*. 34 (2):247-250.

OECD, 2001. Consensus document on compositional considerations for new varieties of soybean: Key food and feed nutrients and antinutrients. Environment Directorate Organisation for Economic Co-operation and Development, Paris, France, pp:30. http://www.oecd.org/dataoecd/15/60/46815135.pdf.

Ojo, R.J., Oguche, P.I., Kube, G.D., Udzer, T.E., (2013). Effect of Jatropha curcas supplemented diet on broilers. *Scholars Academic Journal of Biosciences.* 1 (6):329-336.

Peter, R., Ferket & Abel G. Gernat (2006). Factors that affect feed intake of meat birds. A review. *International Journal of Poultry Science. 5(10):905-911. ISSN: 1682-8356. (c) Asian Network for Scientific Information.*

SAS, (2015). Software Package Statistical Analytical System. SAS 9.2 User's Guide Statistics. SAS Institute Inc. Cary Norway.

Wafar, R.J., Ademu, L.A., Kirifi, Y.B. and Shehu, I.I. (2016). Effects of processing methodsnon the utilization of Mucuana sloanei (Horse Eye Bean) Seed meal by Broiler chicken. *British Journal of Applied Research* 1(1), 0010-0014.

Wafar, R.J., Yakubu, B., Yusuf, H.B. and Antyev, M. (2018). Effect of feeding raw and differently processed kapok (Ceiba pentandra) seed meal on the growth performance and carcass characteristics of weaner rabbits. *Nigerian Journal of Animal Science*. 20(2): 258-270.

59 EFFECTS OF THE METHANOL LEAF EXTRACT OF Newbouldia laevis ON OESTROGEN LEVELS DURING PREGNANCY IN RABBIT DOES IN KADUNA STATE, NIGERIA

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Abstract
This study evaluated the effects of the methanol leaf extract of Newbouldialaevis on oestrogen levels during pregnancy in rabbit does. The leaves of N. laevis were collected,authenticated and identified at the Herbarium in the Botany unit, Department of Biological Science, Faculty of Life Science, A.B.U. Zaria.The leaves were later extracted using 99.8 % methanol and the median lethal dose (LD_{50}) of extract was determined using Lorke's method. Twenty, 6 ± 2.0 months old does, with average body weight of 1.40 kg were housed individually and randomly assigned into 4 groups comprising 5 does each. Rabbits in groups A, B and C were administered the methanol leaf extract of N. laevis at dose rates of 1000mg/kg, 500mg/kg and 250mg/kg, respectively, while those in group D (control) were fed rabbit diet and water ad libitumfor 48 days. Does were bred through natural mating at day 27 of extract administration, pregnancy was diagnosed through gentle palpation of the abdomen. Blood samples were collected from each doe on days 0, 6, 21, 27, 34, 41 and 48 post extract administration and analysed for estradiol (E2) levels using enzyme linked immunosorbent assay (ELISA). There was nostatistical significant($P>0.05$) difference in mean (± SEM) E2 levels between groups at days 0 and 6 of extract administration. At day 21 of extract administration, there was significantly higher ($P<0.05$) mean (± SEM) E2 level in group A (261.18 ± 60.98 pg/mL) than in groups B (50.33 ± 50.19 pg/mL), C (0.19 ± 0.03 pg/mL) and D (0.14 ± 0.02 pg/mL). At days 27 (does were bred), 41(14 days of gestation) and 48 (21 days of gestation) of extract administration, the mean (± SEM) E2 levels showed no significant differences ($P>0.05$) in all groups of does; but it was significantly higher ($P<0.05$) in groups A(16.75±5.11 pg/mL), B(14.42±1.68 pg/mL) and C(12.18±1.71 pg/mL) compared to group D (0.12±0.02 pg/mL) at day 34 (7 days of gestation).

Keywords: Methanol leaf extract, *Newbouldia leavis*, Oestrogen, Pregnancy and Rabbit

Introduction

The use of traditional medicine cannot fade out in the treatment and management of diseases in African continent and this could be attributed to socio-cultural and socio-economic life styles; lack of basic health care and qualified personnel (Elujoba*etal*., 2005).The use of plants to facilitate birth or to protect the young embryo appears to be a common practice among traditional healers. *Newbouldia laevis* is one of such plants and its leaves are used in Southeastern Nigeria to hasten parturition and to expel the placenta after delivery (Obute, 2002).

Infertility is a major clinical problem affecting animals medically and psychologically (Akomolafe, 2012). The management options available for the treatment of infertility in males include the use of drugs and a variety of surgical procedures (Purvis *et al*., 2008). Genetic improvement of rabbits is important in order

to increase their contribution to the muchneeded animal protein in Nigeria. A prerequisite for this improvement is the knowledge of their breeding pattern and the ability to select for high prolificacy which is lacking in Nigeria(Fayeye and Ayorinde, 2003; 2010).
The use of plant extracts as fertility enhancer in animals is now on the increase because of the shifting attention from synthetic drugs to natural plant products (Dada and Ajilore, 2009).

Rabbit meat is not only a cheap source of animal protein; it also serves as an alternative investment and source of additional income in the rural areas(Onyinyechi, 2015). In developing countries, rabbits are emerging as low-cost answer to the problems of hunger and low protein intake of poor rural dwellers (Adedeji *et al*., 2015).This work is therefore designed to investigate the effects of the methanol leaf extract of *Newbouldialaevis* on oestrogen levels during pregnancy in rabbit does with a view to improving reproductive performance.

Hypothesis: There is significant differences between E2 levels between the groups.

Methodology
This Study was carried out at the Department of Theriogenology and Production, Faculty of Veterinary Medicine, Ahmadu Bello University (A.B.U) Zaria. The University is located in the Northern Guinea Savannah Zone of Nigeria between latitude 11°3′N and 12°N and longitude 7°42′E and 8°E at an elevation of 650m above sea level with an average annual temperature of 18.0 ± 3.7°C to 31.8 ± 3.2°C(www.world66.com)
Twenty disease free female domestic rabbits(*Oryctolagus cuniculus*) of six months old and average body weight 1400-2000g were used for this study. The experiment was carried out under normal ambient temperature and each doe housed in standard rabbit cages. The does were screened against diseases, treated with Kepromec® for ectoparasite infestation and allowed to acclimatize for six weeks before the commencement of the experiment. Water and feed were provided *ad libitum*.
The leaves of *N. laevis* were washed to remove soil and other debris, then air-dried for 5 days from its moisture level of 85% and ground into a powder. A portion of the powder was macerated in 70% methanol for 48hours. The extract was decanted, filtered and concentrated in a vacuum evaporator at 60°C and dried in an oven set at 40°C. The extract was stored in an air tight container in the refrigerator.
The does were randomly divided into four groups; A, B,C and D each comprising of five does. Groups A, B and C were administered with the methanol leaf extract of *N.laevis* at 1000 mg/kg, 500 mg/kg and 250 mg/kg respectively for 48 days, and group D was control. The does were bred at day 27 of extract administration and after conception all does were allowed to carry pregnancy to term. Water was provided to all does *ad libitum* and extract administration was continued until kindling.
Blood sample (2 mL) was collected from each doe in all groups into labeled plain tubes without anticoagulant at days 0, 6, 21, 27, 34, 41 and 48 of extract administration. Each blood sample was allowed to clot, centrifuged at 3000 × g for 15 minutes and serum was harvested into a labeled serum bottle through centrifugation method Thereafter, the serum was stored at -20°C until analysed for estradiol levels using estradiol enzyme linked immunosorbent assay (ELISA) kit (Accu-bind®) according to the manufacturer’s instructions.

Data on E2 levels were expressed as Mean±SEM (standard error of mean), subjected to Repeated-Meaures-one Way An alysis of Variance (ANOVA).

Results and Discussion

Changes in mean (± sem) serum oestrogen levels

The mean (± SEM) serum oestrogen(E2) levels (pg/mL) of rabbit does administer methanol leaf extract of *Newbouldialaevis* before breeding and during pregnancy are presented in Table I. At day 0, there was no statistical significance (P>0.05) difference in mean (± SEM) E2 level between groups A (167.15 ± 14.29 pg/mL) and B (156.78 ± 90.20 pg/mL) but these were non-significantly (P>0.05) lower compared to groups C (206.25 ± 52.78 pg/mL) and D (231.34 ± 21.92 pg/mL).

At day 6 of extract administration, mean (± SEM) E2 level was non-significantly higher (P>0.05) in group D (282.45 ± 31.46 pg/mL) than in groups A (219.68 ± 23.10 pg/mL), B (202.01 ± 111.47 pg/mL) and C (250.39 ± 55.03 pg/mL). The mean (± SEM) E2 level in group A (261.18 ± 60.98 pg/mL) was significantly higher (P<0.05) than in groups B (50.33 ± 50.19 pg/mL), C (0.19 ± 0.03 pg/mL) and D (0.14 ± 0.02 pg/mL) at day 21 of extract administration. Also, mean (± SEM) E2 level was significantly higher (P<0.05) in group B than in groups C and D, but showed no significant difference (P>0.05) between groups C and D at day 21 of extract administration.

At days 27of extract administration (breeding), no significant differences (P>0.05) existed in mean (± SEM) E2 levels in all groups of does. The mean (± SEM) E2 level was significantly higher (P<0.05) in groups A (16.75 ± 5.11 pg/mL), B (14.42 ± 1.68 pg/mL) and C (12.18 ± 1.71 pg/mL) compared to group D (0.12 ± 0.02 pg/mL) at day 34(7 days of gestation) of extract administration.

At 41 days (14 days of gestation) of extract administration, there was significantly lower mean (± SEM) E2 level in does of group C (11.55 ± 1.45 pg/mL) than in D (16.86 ± 0.44 pg/mL) but with no significant difference compared to groups A (12.38 ± 3.22 pg/mL) and B (14.49 ± 1.70 pg/mL). At48 days (21 days of gestation) of extract administration, the mean (± SEM) E2 level showed no significant differences (P>0.05) in all groups of does but was non-significantly higher in group B (18.07 ±2.47 pg/mL).

Discussion

Oestrogen(E2) is responsible for the development of female sex organs, preparation of the reproductive tract for pregnancy and mating behaviours and plays a critical role during pregnancy in rabbit does (Gadsby *et al*., 1983; Mustafa and Elhanbaly, 2020). In this study, there was variation in the E2 levels of does administered methanolic leaf extract of *N.laevis*before breeding and during pregnancy.At days 0 and 6 of extract administration, the E2 levels were high in all does but there was non-significantly higher levels in the does administered 250 mg/kg of extract. High E2 levels were reported to be indicative of oestrus and readiness for mating (Marcondes *et al*., 2002; Ermayanti*et al*., 2019; Ajayi and Akhigbe, 2020). The findings from this study showed fluctuations in the E2 levels and these were not unusual. This is because rabbit does are induced or reflex ovulators as ovulation majorly takes place after mating thus making them not to have a regular oestrous cycle found in other domestic animals such as cattle (Hoffman *et al*., 2010; Lone *et al*., 2017).

Table I: Mean(±sem) serum oestrogen levels(pg/ml) of rabbit does administered methanol leaf extract of *newbouldia laevis* before breeding and during pregnancy

Days of extract administration	A	B	C	D
	1000 mg/kg	500 mg/kg	250 mg/kg	Control
0	167.15 ± 14.29^{a}	156.78 ± 90.20^{a}	206.25 ± 52.78^{a}	231.34 ± 21.92^{a}
6	219.68 ± 23.10^{a}	202.01 ± 111.47^{a}	250.39 ± 55.03^{a}	282.45 ± 31.46^{a}
21	261.18 ± 60.98^{a}	50.33 ± 50.19^{b}	0.19 ± 0.03^{c}	0.14 ± 0.02^{c}
27	0.16 ± 0.05^{a}	0.14 ± 0.02^{a}	0.17 ± 0.02^{a}	0.14 ± 0.02^{a}
34	16.75 ± 5.11^{a}	14.42 ± 1.68^{a}	12.18 ± 1.71^{a}	0.12 ± 0.02^{b}
41	12.38 ± 3.22^{ab}	14.49 ± 1.70^{ab}	11.55 ± 1.45^{a}	16.86 ± 0.44^{b}
48	14.03 ± 1.98^{a}	18.07 ± 2.47^{a}	14.43 ± 2.91^{a}	15.88 ± 1.07^{a}

Mean (± SEM) values with different superscript alphabets along the same row differ significantly at $P<0.05$.

During pregnancy, E2 levels were significantly higher in does administered 1000, 500 and 250 mg/kg of extract compared to control at 34 days of extract administration (7 days post-breeding) but were lower than their values at days 0 and 6. The E2 levels showed non-significant fluctuations in does administered the extracts at days 41 and 48 of extract administration while that of the control increased on days 41 and 48. In the study of Klaus and Uwe (1988), lower E2 levels in nonpregnant and non-lactating does compared to during pregnancywere reported with a relatively high level recorded in the first week of pregnancy. Challis *et al*. (1973) in another study reported only a slight increase in E2 level from day 21 to 30 of pregnancy while Lau *et al*. (1982) reported a decrease in serum E2 level at the same time.

Bostanci *et al*. (2012) reportedE2 level of 98.1pg/mL during the second half of gestation and Kirat *et al*. (2015) reported E2 level of 5.5 pg/mL at the 10th day of gestation in does. On day 21 of gestation, Gonzalez- Mariscal *et al*. (2009) documented E2 level of 24± 6 pg/mL while a level 10.5 pg/mL was reported by Kirat *et al*. (2012). Ashour and Abdel-Rahman (2019) recorded E2 levels of 47.31 ± 4.99 pg/mL and 56.33± 5.34 pg/mL on days 14 and 21 of gestation respectively. The extract administration may be responsible for the differences in the pattern of E2 levels observed in the present study compared to other studies. This might be linked to the alkaloids and flavonoids contained in the *N. laevis* leaf extract as these constituents were previously suggested to reduce plasma concentrations of some fertility hormones (Browning *et al*., 1998; Bianco et al., 2006)..

In male albino rats, the aqueous leaf extract of *N. laevis* was reported to modulate some fertility hormones such as testosterone, follicle stimulating and luteinizing hormones thus suggesting that the extract could act as an adjunct that can inhibit or promote hormonal imbalances in males at certain dosages (Egba*et al*., 2014). Oladimeji and Aroyehun (2015) on other hand suggested that *N. laevis* leaf extract could provide pro-fertility effects and ameliorate the effect of hormone induced pathologies in female albino rats. This study has therefore demonstrated outcome of investigation on the effects of *N. laevis* methanol leaf extract on oestrogen levels during pregnancy in rabbit does.

Conclusion

From this studythere were no significant difference (P>0.05) in E2 levels in all groups of does at days 27 (breeding), 41 (14 days of gestation) and 48 (21 days of gestation).The E2 level was significantly higher (P<0.05) in does administered 1000 mg/kg (16.75 ± 5.11 pg/mL), 500 mg/kg (14.42 ± 1.68 pg/mL) and 250 mg/kg (12.18 ± 1.71 pg/mL) of *N. laevis*leaf extract compared to control (0.12 ± 0.02 pg/mL) at day 34 (7 days of gestation) of extract administration.Peak E2 level was observed at day 34 (7 days of gestation) in does administered 1000 mg/kg (16.75 ± 5.11 pg/mL)*N.laevis*leaf extract, day 48 (21 days of gestation) in does administered 500 mg/kg (18.07 ± 2.47 pg/mL) and 250 mg/kg (14.43 ± 2.91 pg/mL) *N. laevis*leaf extract and day 41 (14 days of gestation) in control (16.86 ± 0.44 pg/mL).

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References

Adedeji, O.A., Ajibade, M.O. and Folayan, J.A.(2015). Effect of Aspillia Africana leave on reproduction of rabbit. *Journal of Development and Agricultural Economics*,7(6):231-236.

Ajayi, A. F. and Akhigbe, R. E. (2020). Staging of the estrous cycle and induction of estrus in experimental rodents: an update. *Fertility Research and Practice*, 6(5):1-15. https://doi.org/10.1186/s40738-020-00074-3

Akomolafe, S.F., Ganiyu, O.A., Akindahunsi, A.J and Akinyemi, O.A (2012). Inhibitory Effect of Aqueous Extract of Moringa oleifera and Newbuoldialaevis Leaves on Ferrous Sulphate and Sodium Nitroprusside Induced Oxidative Stress in Rat's Testes in Vitro. *Open Journal of Medicinal Chemistry, 2, 119-128.*

Ashour G and Abdel-Rahman SM (2019). Hormonal Changes in Relation to Productivity of Pregnant Rabbit Does.*World Veterinary Journal*9(1): 37-45.

Bianco, F., Basini, G. and Grasselli, F. (2006). The plant alkaloid Sanguinarine affects swine granulose cell activity. *Reproductive Toxicology*, 21: 335-340.

Bostanci MS, Merih B and Zuhal AK (2012). The effects of ascorbic acid on the estrogen/ progesterone levels in the isolated rabbit uterine muscle. *Journal of Clinical Gynecology and Obstetrics*, 1: 63-66.

Browning, R., Schrick, F.N., Thompson, F.W. and Wakefield, T. (1998). Reproductive hormonal responses to ergotamine and ergonovine in cows during the luteal phase of the estrous cycle.*Journal of Animal Sciences*, 76: 1448-1454.

Challis J. R. G., Davies 1. J. and Ryan K. J. (1973).The concentrations of progesterone, esterone and estradiol-17β in the myometrium of the pregnant rabbit and their relationship to the peripheral plasma steroid concentrations.*Endocrinology*, 95: 161-164.

Dada, A.A. and Ajilore, V.O. (2009). Use of ethanol extracts of Garcinia kola as fertility enhancer in female catfish Clariasgariepinusbroodstock. *International Journal of Fish. and Aquacul*ture, 1 (1): 005-010.

Egba, S. I., Sunday, G. I. and Anaduaka, E. G. (2014). The effect of oral administration of aqueous extract of *Newbouldialaevis* leaves on fertility hormones of male albino rats. *IOSR Journal of Pharmacy and Biological Sciences*, 9(3): 61-64.

Elujoba, A.A., Odeleye, O.M. and Ogunyemi, C.M. (2005).Traditional medicine development for medical and dental primary health care delivery system in Africa. *African Journal of Traditional, Complementary and Alternative Medicines*, 2(1): 46-61.

Ermayanti, N. G. A. M., Suaskara, I. B. M., Setyawati, I., Suarni, N. M. R. and Widhyastini, I. G. A. M. (2019). Estrogen level in female local rabbit fed commercial cod liver oil supplementation. *IOP Conference Series: Earth and Environmental Science*, 347: 1-5.

Fayeye, T.R. and Ayorinde, K.L.(2003). Litter growth and weaning characteristics in two generations of straightbred and cross bred rabbit. *Nigerian Journal of Genetics. 18: 68-72.*

Fayeye, T.R. and Ayorinde, K.L.(2010).Effects of season, generation,number of matings, parity and doe number of teat on doe and litter birth characteristics in domestic rabbit. *Research Journal of Animal and Veterinary Sciences. 5:6-9*

Gadsby, J. E., Keyes, P. L. and Bill, C. H. (1983). Control of corpus luteum function in the pregnant rabbit: role of estrogen and lack of a direct luteotropic role of the placenta. *Endocrinology*, 113(6): 2255-2262.

González-Mariscal G, Gallegos JA, Sierra-Ramírez A and Garza Flores J (2009).Impact of concurrent pregnancy and lactation on maternal nest building, estradiol and progesterone concentrations in rabbits.World Rabbit Science, 17: 145 –152.

Hoffman, K. L., Morales, R. I. R. and González-Mariscal, G. (2010).Relevance of mating-associated stimuli, ovulation, and the progesterone receptor for the post-coital inhibition of estrous behavior in the female rabbit.*Hormones and Behavior*, 58(5): 747-753.

Kirat D, Abdel Hamid NE, Mohamed WE, Hamada M and Shalaby SI (2015).Leptin gene expression in rabbits during pregnancy and fetal life. *International Journal of Biology*, 7: 113-125.

Klaus, K. and Uwe, M. (1988).Concentrations of serum cortisol, progesterone, estradiol-17β, cholesterol and cholesterol ester in the doe during the reproductive stadium, in the fetal serum, in the amniotic fluid and in the milk of rabbits, as well as correlations between these parameters.*Comparative Biochemistry and Physiology Part A: Physiology*, 90(3): 413-420.

Lau I. F., Saksena S. K. and Salmonsen R. (1982).The concentration of progesterone, 20α-dihydroprogesterone, testosterone and oestradiol-17β in serum, amniotic fluid and placental tissue of pregnant rabbits.*ActaEndocrinologia*, 99: 605-611.

Lone, S. A., Shah, N., Singh, A. and Puneeth-Kumar, D. S. (2017). Nature, effects and possible mechanisms of action of ovulation inducing factor: A review. *International Journal of Livestock Research*, 7(4): 59-67.

Marcondes, F. K., Bianchi, F. J. and Tanno, A. P. (2002). Determination of the estrous cycle phases of rats: some helpful considerations. *Brazillian Journal of Biology*, 62(4): 609-614.

Mustafa, F. E. A. and Elhanbaly, R. (2020). Distribution of estrogen receptor in the rabbit cervix during pregnancy with special reference to stromal elements: an immunohistochemical study. Scientific Reports, 10: 13655. https://doi.org/10.1038/s41598-020-70323-4

Oladimeji, S. O. and Aroyehun, A. B. (2015). The hormonal profile and some immune factors of induced infertile female albino rats treated with the ethanolic leave extract of *Newbouldialaevis*. *International Journal of Medicine and Health Profession Research, 2(1): 1-8.*

Obute GC. Ethnomedicinal plant resources of Southeastern Nigeria [editorial] 2002. Available from: http://www.siu.edu/webl/leaflets/; 1,(1)[accessed on 2007 Aug 13].

Onyinyechi, I.O.(2015). Roles of Households in Rabbit Production in Enugu-North Agricultural zone of Enugu State.*Journal of Agricultural Extension, Vol. 19(1) June,2015.*

Purvis, K. and Christiansen, E. (2008). Infection in the male reproductive tract.Impact, diagnosis and treatment in relation to male infertility. *International Journal on Andrology, 16(1): 1-13*

60 GROWTH AND BODY MORPHOMETRIC PARAMETERS OF BROILER CHICKENS ORALLY ADMINISTERED VARYING LEVELS OF LEMONGRASS EXTRACT, AT FINISHER PHASE

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Abstract

The growth and body morphometric parameters of broiler chickens orally administered varying levels of lemongrass extract at finisher phase was evaluated. A total of 150-day old broiler chicks were used for this study in a CRD design. The birds were allotted into five treatments of 30 chicks in each treatment with three replications of 10 chicks per replicate. The control (T1) group was not administered antibiotic nor lemongrass extract and treatment group T2 was administered 0.2mls of antibiotic while T3, T4 and T5 treatment groups were administered 0.2mls, 0.4mls and 0.6mls of lemongrass extract respectively. Data on the growth and morphometric parameters were collected. There was no significant difference (P>0.05) in the growth parameters with an exception of the average initial body weight. The average final body weight (g) in T1, T2, T3, T4 and T5 were 1781.48, 1767.59, 2061.90, 1897.62 and 1898.31 respectively. The average body weight of broiler birds in T3 was higher as compared to those in T1, T2, T4 and T5. The body weight gain in T1, T2, T3, T4 and T5 were 1249.78, 1266.22, 1458.24, 1386.54, and 1420.91 respectively. The birds in treatment groups T3, T4 and T5 recorded higher weight gain than T1 (control group) and T2 (0.2mls antibiotic). The feed intake (g) were 359.87, 3152.33, 4039.16, 3777.33, 4063.40 in treatment T1, T2, T3, T4 and T5 respectively. The treatment group T5 consumed more feed (4063.40g) compared to the other treatments. Feed conversion ratio was higher in T5 (2.82) as compared to T1 (2.81), T2 (2.49), T3 (2.77) and T4 (2.73). However, there were significant (P<0.05) differences in average initial body width, final body girth, final shank length and shank length gain compare to other parameters such as initial body length, final body length, body length gain, body width gain, final body width, initial shank length, initial neck length, final neck length, which were not significantly affected. It can be concluded that the use of lemongrass extract at the levels 0.6mls and 0.2mls proved to have improved the growth performance as well as better performance of the morphometric parameters.

Key words: Growth, Morphometric, Broiler chicken, oral Administration, lemongrass extract, Finisher phase

Introduction

Antibiotics have been routinely utilized as a growth promoter to improve growth and overall performance in poultry and livestock production for decades. Antibiotic use as a growth stimulant particularly at subtherapeutic dosages, has resulted in bacterial resistance, cross resistance, and multiple resistance (Gould, 2008). According to Van de Bogaard and Stobberingh (2000), resistant bacteria can be spread from chicken products to the human population by consumption or handling of contaminated poultry meat. As a result of this, strict regulations have been placed on antibiotic growth promoters, hence a lot of interests were now focussed on the search for substitute to antibiotic growth promoters.

One of the natural alternatives to antibiotic which has been observed to increase performance in poultry is lemongrass (Peter and Babu, 2012). Lemongrass is a herb that has been shown to offer medical and therapeutic advantages. Shah *et al*. (2011) noted that it contains phytochemical compounds like flavonoids, phenolic compounds, and essential oils like citral, nerolgeraniol, citronellal, terpinolene, and geranylmethyl heptenone, which may be responsible for its antibacterial, antidiarrheal, antifungal, antioxidant, and growth promoter properties. Previous researchers had considered the use of lemongrass leaf meal in broiler diets. Mmereole (2010) noted that, the addition of lemongrass in the diet of poultry as feed additive gave improved performance of broiler chickens. However, lemongrass has a high fibre content of about 9.30% (Thorat *et al.*, 2017), which is less than the 5% requirement for broilers (Olomu, 2011). This high fibre content thus will limit the utilization of lemongrass meal as a growth promoter despite its potential, thus reducing the ability of lemongrass meal to promote growth maximally due to the fact that minute quantity of the feed is being consumed by the birds because of the high fibre. It is on this thought that this research contemplated the oral administration of lemongrass extract which contain no fibre. The mode of administration as well will ensures maximum intake and hoped to maximize the already established potential of lemongrass as growth promoting alternative, as should be evident in the growth and morphometric parameters of the broiler chickens.

Materials and Method

The experiment was carried out at the poultry unit of the Extractching and Research Farm, Federal University of Technology, Minna, Gidan kwano, Minna, Niger State. Minna is located at 09° 36' 50” north latitude and 06° 33' 25” east longitude, in degrees minutes' seconds. It is 700,000 meters above sea level and is surrounded by a river that travels from the northwestern to the southwestern parts of the state. It is located in the country's Southern Guinea Savannah agro-ecological zone. The daytime temperature ranges from 38° C in the start of the wet season to 28° C in the middle. The yearly rainfall average is 1209.7 mm (Minna Niger Geography, 2004 - 2017).

Source of Experimental Materials

One hundred and Fifty (150) day old broiler chicks were purchased from Agrited hatchery Ibadan, Oyo State. Lemongrass was harvested from households in Minna, Niger State, dried at room temperature to a moisture content of 10% and grinded into powder form to make the extract. Commercial feed containing 18-20% crude protein and 2950-3210kcal/kgDM (finisher feed) was purchased from an accredited feed dealer in Minna, Niger State.

Management of Experimental Birds and Design

This research utilized a Completely Randomized Design (CRD) arrangement with five treatments, each with three replicates and ten birds per replicate. Thus, a total of 150 broiler chickens was used. The study lasted for 4 weeks of the finisher phase. A week before the birds arrived, the pen and cage were cleaned and disinfected. Before the birds arrived, the feeders and drinkers were cleaned before the arrival of the birds, charcoal stoves were used as sources of heat during the brooding period. Lamp was used as source of light. Washing drinking and feeding troughs, removing litter items, and providing feed were all done on a regular basis.

Preparation of experimental lemongrass extract

Fresh Lemongrass leaves were dried under room temperature to a moisture content of about 10% and ground. 20g of the lemongrass was boiled in water 1 litre of water at 100^{o}C for 10 minutes and then allowed to cool for 12 hours before orally administering it to the birds. The levels of administration of the lemongrass extract is shown in table 1.

Experimental Diets

The birds were given a commercial feed and clean drinking water *ad libitum* throughout the duration of the study. Starter feed containing 22-24% crude protein and 2800-2900kcal/kgDM was given for a period of 4 weeks. Finisher feed containing 18-20% crude protein and 2950-3210kcal/kgDM was given from the fifth to eight week.

Data collection

Data on growth parameters collected were body weight, body weight gain, feed intake and feed conversion ratio. The body morphometric traits that were assessed were body length (BL), body girth (BG), shank length (SL), body width (BW), neck length (NL)

Table 1. Levels of lemongrass extract administered

Treatments	Levels of lemongrass extract administered
T1	0% antibiotic & 0% lemongrass extract (negative control)
T2	0.2 mls of synthetic antibiotic (positive control)
T3	0.2 mls of lemongrass extract
T4	0.4 mls of lemongrass extract
T5	0.6 mls of lemongrass extract

Data analysis

All data collected were statistically analyzed using one-way analysis of variance (ANOVA) of SPSS 16.0 program (statistical package for the social sciences). Duncan multiple range testing was used to separate mean values where they arise.

Results

Growth performance of Broiler chickens administered varying levels of lemongrass extract at finisher phase.

The results of the growth performance of broiler chickens orally administered varying levels of lemon grass extract at finisher phase is shown in table 2. The results obtained showed that the initial body weight (at 5th weeks) was significantly different ($p<0.05$) across the treatments. The highest initial body weight was obtained in T3 (603.67g) of birds administered 0.2ml of lemon grass extract and the lowest initial body weight was recorded in T5 (477.40g) administered 0.6ml of lemon grass extract. However the feed intake, weekly feed intake, daily feed intake, feed conversion ratio, final body weight body weight gain, weekly body weight gain and daily weight gain were not significantly ($P>0.05$) affected. The highest feed intake (4063.40g), weekly feed intake (1015.85g), daily feed intake (145.12g) and feed conversion ratio (2.82) were observed in T5 of birds administered 0.6ml of lemon grass extract. The least feed intake was obtained in T1 (359.87g) control group. The lowest weekly feed intake, daily feed intake and feed conversation

Table 2. Growth performance of broiler birds administered varying levels of lemongrass extract at finisher phase

Parameters	T1	T2	T3	T4	T5	SEM	LS
AFI (g)	359.87	3152.33	4039.16	3777.33	4063.40	201.52	NS
AWFI (g)	898.22	788.08	1009.79	944.33	1015.85	55.04	NS
ADF I(g)	128.32	112.59	144.26	134.91	145.12	7.86	NS
FCR	2.81	2.49	2.77	2.73	2.82	0.99	NS
AIBW (g)	531.70^{ab}	501.38^{ab}	603.67^{a}	511.08^{ab}	477.40^{b}	17.21	*
AFBW (g)	1781.48	1767.59	2061.90	1897.62	1898.31	46.42	NS
ABWG (g)	1249.78	1266.22	1458.24	1386.54	1420.91	39.65	NS
AWBWG (g)	312.44	316.56	364.56	346.64	355.23	9.91	NS
ADBWG (g)	44.63	45.22	52.08	49.52	50.75	1.42	NS

Key-SEM: standard error of mean, LS: level of significance; NS: No significant difference; *: There is significant difference; TI; control, T2 ; 0.2mls of antibiotic,T3; 0.2mls of LMGT, T4; 0.4mls of LMGT, T5; 0.6mls of LMGT, LMGT = lemongrass extract, AFI = average feed intake, ADFI = average daily feed intake, FCR = feed conversion ratio, AIBW = average initial body weight, AFBW = average final body weight, ABWG = average body weight gain, AWBWG = average weekly body weight gain, ADBWG = average daily body weight gain.

were obtained in T2 of birds administered synthetic antibiotics as 788.08g, 112.59g and 2.49 respectively. The least final body weight was observed in T2 (1767.5g) of birds administered synthetic antibiotic. The lowest body weight gain, weekly body weight gain and daily weight gain were obtained in T1 (control) as 1249.78g 312.44 and 44.63g respectively.

Morphometric performance of broiler chickens orally administered varying levels of lemongrass extract at finisher phase

The results of the morphometric parameters of broilers birds orally administered varying levels of lemon grass extract is shown in table 3. The results obtained showed that the initial body width, final body girth, final shank length, shank length gain, weekly shank length gain and daily shank length gain were significantly ($p<0.05$) different with T2 having the highest initial body width (16.99cm) while T5 recorded the least (15.58cm).T3 had the highest final body girth (42.63cm) while T5 recorded the least (40.74cm). the highest final, shank length gain, weekly shank length gain and daily shank length gain were recorded in T1 (control) as 18.63cm, 6.89cm, 1.72cm and 0.25cm respectively while the lowest final, shank length gain, weekly shank length gain and daily shank length were observed in T5 as 17.50cm,5.47cm, 1.36cm and 0.19cm respectively. However there were no significant differences (P>0.05) in the initial body length, final body length, body length gain, weekly body length gain, daily length gain, final body width, body width gain, weekly body width gain, daily body width gain, initial body girth, body girth gain, weekly body girth gain, daily body girth gain, initial shank length, initial neck length, final neck length, neck length gain, weekly neck length gain and daily neck length gain.

Discussion

There was no significant (P>0.05) difference in the growth performance of broiler chickens administered varying levels of lemongrass extract considering growth parameters such as feed intake, weekly feed intake, daily feed intake, feed conversion ratio, final body weight, body weight gain, weekly body weight gain, and daily body weight gain with an exception of the initial body weight which was significantly (p<0.05) different and differs across the treatment groups. This result was however, at variance with Mmereole (2010), who reported that the inclusion of *cymbopogon citratus* (lemongrass) leaf meal in poultry diet resulted in a significant difference in the performance of the growth parameters of the broiler birds. The disagreement could have been due to the mode of lemongrass administration. The author administered lemongrass as feed additive and this could have resulted in the continuous feeding and accumulated effect of the lemongrass, that could have reflected in the significant difference observed in the growth parameters as against the oral administration of lemongrass extract at weekly bases carried out in this study.

The results of the morphometric parameters of broilers birds orally administered varying levels of lemon grass extract showed that the initial body width, final body girth, final shank length, shank length gain, weekly shank length gain and daily shank length gain were significantly (p<0.05) different with T2 having the highest initial body width (16.99cm) while T5 recorded the least (15.58cm). T3 had the highest final body girth (42.63cm) while T5 recorded the least (40.74cm). the highest final, shank length gain, weekly shank length gain and daily shank length gain were recorded in T1 (control) as 18.63cm, 6.89cm, 1.72cm and 0.25cm respectively while the lowest final, shank length gain, weekly shank length gain and daily shank length were observed in T5 as 17.50cm,5.47cm, 1.36cm and 0.19cm respectively. However, there were no significant differences (P>0.05) in the initial body length, final body length, body length gain, weekly body length gain, daily length gain, final body width, body width gain, weekly body width gain, daily body width gain, initial body girth, body girth gain, weekly body girth gain, daily body girth gain, initial shank length, initial neck length, final neck length, neck length gain, weekly neck length gain and daily neck length gain. The variation in the results recorded in this study could have been due to different levels of administration of lemongrass extract.

Table 3. Morphometric parameters of broiler birds administered varying levels of lemongrass extract at finisher phase

PARAMETERS (cm)	T1	T2	T3	T4	T5	SEM	LS
Average initial body length	24.66	24.31	25.06	24.5	24.6	0.15	NS
Average final body length	39.96	39.45	40.01	41.5	39.42	0.53	NS
Average body length gain	15.29	15.14	14.95	17	14.82	0.55	NS
Average weekly body length gain	3.82	3.79	3.74	4.25	3.71	0.14	NS
Average daily body length gain	0.54	0.54	0.53	0.61	0.53	0.02	NS
Average initial body width	16.85^{a}	16.99^{a}	16.79^{a}	16.43^{a}	15.58^{b}	0.17	*
Average final body width	27.56	26.97	27.62	26.15	26.75	0.27	NS
Average body width gain	10.71	9.97	10.83	9.72	11.17	0.27	NS
Average weekly body width gain	2.68	2.49	2.71	2.43	2.79	0.07	NS
Average daily body width gain	0.38	0.36	0.39	0.35	0.39	0.01	NS
Average initial body girth	24.51	24.57	24.48	24.77	24.01	0.25	NS
Average final body girth	41.95^{ab}	41.42^{ab}	42.63^{a}	41.11^{ab}	40.74^{b}	0.27	*
Average weekly body girth gain	4.36	4.21	4.54	4.09	4.18	0.07	NS
Average daily body girth gain	0.62	0.6	0.65	0.58	0.59	0.01	NS
Average initial shank length	11.73	11.39	12.28	12.32	12.03	0.2	NS
Average final shank length	18.63^{a}	17.83^{ab}	18.29^{ab}	17.54^{b}	17.50^{b}	0.16	*
Average shank length gain	6.89^{a}	6.45^{ab}	6.01^{ab}	5.22^{b}	5.47^{ab}	0.25	*
Average body girth gain	17.43	16.85	18.15	16.34	16.74	0.27	NS
Average weekly shank length gain	1.72^{a}	1.61^{ab}	1.50^{ab}	1.31^{b}	1.36^{ab}	0.06	*
Average daily shank length gain	0.25^{a}	0.23^{ab}	0.21^{ab}	0.18^{b}	0.19^{ab}	0.01	*
Average initial neck length	8.19	7.75	7.6	8.24	7.63	0.14	NS
Average final neck length	14.94	15.41	15.96	15.59	15.31	0.19	NS
Average neck length gain	6.75	7.66	8.36	7.36	7.68	0.28	NS
Average weekly neck length gain	1.69	1.92	2.09	1.84	1.92	0.07	NS
Average daily neck length gain	0.24	0.27	0.29	0.26	0.28	0.01	NS

Key- SEM: standard error of mean; LS: Level of significance; NS: No significant difference; *: there is significant difference; LGT; Lemongrass extract. TI; control, T2; 0.2mls of antibiotic, T3; 0.2mls of LMGT, T4; 0.4mls of LMGT, T5; 0.6mls of LMGT.

Conclusion

Based on the available results, it is concluded that lemongrass extract used in this experiment gave similar and some cases better performance than the synthetic antibiotic. Antibiotic administration had no superiority over lemongrass extract on the performance of the broiler chickens. The results of this study show that 0.6ml and 0.2ml of lemongrass extract can be recommended to give better performance of birds in terms of feed intake, body weight, body weight gain, average final body girth and average shank length gain.

References

Gold, I.M., (2008). The Epidemiology of antibiotic resistance. *Int. J. Antimicrob*. Agents

Mmereole F. U. C. (2010). Effects of Lemmon Grass *(Cymbopogon citratus)* Leaf Meal Feed Supplement on Growth Performance of Broiler Chicks. *International J. of Poult. Sci*. 9(12):1107-1111.

Olomu (2011). Monogastric nutrition, principles and practice. Second edition st. Jackson Publishing standard.

Peter KV. and KN. Babu (2012). Introduction to herbs and spices: medicinal uses and sustainable production. In Handbook of Herbs and Spices (second edition) 2:1-16.

Shah G, R Shri, V Panchal, N Sharma, B Singh and AS Mann (2011). Scientific basis for the therapeutic use of *Cymbopogon citratus* (Lemon grass). *Journal of Advanced Pharmaceutical Technology and Research* 2:3-8.

Thorat, P.P., Sawate, A.R, Patil Bm., Kshirsagar, R. B (2017). Proximate and phytonutrients Content of lemongrass leaf extract and preparation of herbal cookies. *Int. J. Chem. Stud.* 5(6): 758-762.

Van deBogaard, A.E and E.E. Stobberingh, (2000). Epidemiology of resistance to antibiotics, Link between animals and humans. *Int. J. Antimicrob. Agents*. 14:322-335.

61 THERMOREGULATORY RESPONSES IN PERIPARTURIENT SAHELIAN AND WEST AFRICAN DWARF GOATS DURING THE HOT-DRY SEASON IN THE NORTHERN GUINEA SAVANNAH ZONE OF NIGERIA

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ABSTRACT

The aim of the study was to determine the thermoregulatory responses in periparturient Sahelian (SH) and West African Dwarf (WAD) goats during the hot-dry season in the Northern Guinea Savannah (NGS) zone of Nigeria. A total of twenty cycling does comprise of ten SHG (n =10) and WAD (n =10) goats were used. They were synchronised and bred in December such that the periparturient period coincided with the peak of the hot-dry season. The meteorological parameters, rectal temperature (RT) and respiratory rate (RR) were recorded once weekly; starting from three weeks prepartum until third week postpartum. The recording was done at 07:00, 14:00 and 18:00 h. The results revealed that the meteorological parameters were above the thermoneutral zone established for tropical goats. Mean RT (ºC) was significantly (P < 0.05) higher in SHG compared to WAD at 07:00 h of the prepartum week 2. While the highest mean RT was recorded in WAD at 14:00 h of the prepartum week 3. The overall diurnal fluctuation in RT was significantly (P < 0.05) higher at 14:00 h compared to 07:00 h and 18:00 h irrespective of the breed. The mean RR was significantly (P < 0.05) higher in WAD during postpartum week 1 compared to SHG, regardless of the period of the day. In conclusion, WAD had higher mean RT and RR in comparison to SHG; especially during the immediate postpartum period. Therefore, WAD was able to maintain RT within physiological range in a novel environment at expense of increased RR.

Keywords: Goats, Periparturient period, Heat-stress, Hot-dry season

INTRODUCTION

The periparturient period also termed the transition period (transition from gestation to lactation) is remarkably challenging in ruminants and covers the period 3 weeks pre- and 3 weeks post-parturition (Radin *et al*., 2015). In order to maximize production output, female animals, after attainment of sexual maturity spend substantial part of their life in gestation. In Nigeria, especially the Northern parts, goats are reared in small numbers predominantly under the traditional extensive management system; with little or no shelter from weather and other unfavorable environmental conditions (Timveh *et al*., 2022). Therefore, they are steadily subdued by adverse effects of meteorological stressors throughout the year. Indigenous Nigerian goats are all-year-round breeders (Omontese *et al*., 2016). As such, during pregnancy, they are subjected to concomitant effects of meteorological stressors, gestation and poor quality feed especially during the peak of hot-dry season. Animals exposed to high ambient temperatures activate compensatory mechanisms to dissipate excess thermal load from the body to maintain homeothermy. The compensatory mechanisms exert negative impact on the animals, including elevated net energy for maintenance and, consequently reduction in energy for production (Salama *et al*., 2014).

The West African Dwarf, Red Sokoto and Sahelian goats are the three main goat breeds indigenous to Nigeria. The WAD goat is predominantly found in the southern part of Nigeria; the Red Sokoto goats are indigenous to Niger Republic and the Savannah region of Nigeria; while the Sahelian goats are found in West Africa around the Sahel belt, south of the Sahara (Lawal-Adebowale, 2012). There is an observable trend of introduction of the SHG and WAD goats to the Northern Guinea Savannah (NGS) zone of Nigeria, especially by institutional and commercial farms and unregulated livestock markets (Makun *et al*., 2020). Therefore, there is the need for a detailed understanding of how these breeds are adjusting and adapting to the combined effects of meteorological stressors and pregnancy to attain optimum productivity during the peak of hot-dry season.

MATERIALS AND METHODS

Experimental site and Animal Management

The study was conducted at the Small Ruminant Research section of the National Animal Production Research Institute (NAPRI), Ahmadu Bello University, Shika, Zaria, Nigeria.

Experimental Design and Animals

The study was conducted during the dry season (November – May) and animals were synchronised with Cloprostenol® (at 0.263 mg/mL, IM) and bred during the last week of December, such that the periparturient period and kidding coincided with the peak of the hot-dry season (March and April). Twenty (total n = 20) pure breeds of apparently healthy, cycling does comprising of ten (n=10) each of SHG and WAD goats were used for the study. Dry-bulb and wet-bulb temperatures inside the experimental pens were taken once per week at 07:00 h, 14:00 h and 18:00 h using a hygrometer (Brannan®, UK San Diego, California, U. S. A). Relative humidity (RH) values were extrapolated from the wet and dry-bulb temperatures using conversion tables published by the

Bulletin of the U.S weather Bureau No. 1071. The temperature-humidity index (THI) was calculated according to Ravagnolo *et al*. (2000):

$$THI = (1.8 \times T + 32) - \{(0.55–0.0055 \cdot RH) \cdot (1.8 \times T - 26)\}$$

Where: T is the ambient temperature (°C) and RH the relative humidity (%).

The parameters were determined once weekly at 07:00 h, 14:00 h and 18:00 h throughout the study period.

The RR was determined by counting the number of respiratory flank movements per minute, while the RT was recorded as an indicator of body temperature with the aid of a digital thermometer (Tro-Digitatherm, Hamburg Germany), inserted about 3.5 cm into the rectum until alarm sound was heard, indicating stability of the reading, usually at about 1-2 minutes after insertion of the thermometer (Yaqub *et al*., 2021)..

Data Analysis

The data generated from this study were expressed as mean (±SEM). The difference between groups was analysed using Two-way repeated measure analysis of variance (ANOVA) followed by Tukey's *post hoc* test. While the difference within groups was analysed using repeated measures two-way analysis of variance test followed by Tukey's *post hoc*. The statistical package used was GraphPad Prism version 8.0 for windows (2007) from GraphPad Software, San Diego California, USA. (www.graphpad.com). Values of $P < 0.05$ was considered significant.

RESULTS AND DISCUSSION

Table 1 shows the meteorological parameters recorded during the study. Thermoneutral zone (TNZ) for goat ranges between 22 – 35 ºC for AT and 28 – 60 % for RH (Minka and Ayo, 2016). From this study, the AT was above the upper limit of the TNZ established for tropical goats during the afternoon hour of the study, implying that the goats were heat-stressed. Above the TNZ is the upper critical temperature at which animals must explore the services of energy dissipating mechanisms of the body in order to cool off and maintain homeothermy for optimum production (Salama *et al*., 2021). Rectal temperature was significantly higher in WAD goats during the morning hour (Table 2) regardless of the periparturient stages, except during the week before parturition (prepartum week 1). This finding is in consonance with the studies conducted in the same environment in non-pregnant goats (Habibu *et al*., 2014; Habibu *et al*., 2016). This may be a breed specific trait. It may also indicate that the breed is less adapted to temperature extremes prevailing in the Savannah region of Nigeria. However, the significantly higher RT (Table 2) in WAD during the postpartum period, especially the first week of postpartum, may have been caused by the onset of 'milk-let down' coupled with the climatic extremes of a novel environment that challenged the homeostatic responses of WAD in comparison to the SHG. Furthermore, the significantly higher RR in WAD during the first week of postpartum (Table 3) regardless of the hour of the day compared to SHG suggests that the first postpartum week is more thermally stressful to the WAD. Similar study in goats during heat stress demonstrated a considerable lost in milk component and milk yield (Hamzaoui *et al*., 2013). This finding in WAD could have multifaceted implications considering the challenge of adaptability of the WAD to the novel climatic environment, heat stress and onset of lactogenesis. In spite of higher mean RR in WAD, especially during the afternoon hour, this could not mitigate the rise in RT. Therefore, an increase in RR and RT obviously indicate a lesser adaptability of the WAD in comparison to SHG. While lower RR and RT recorded in SHG suggests that they are more economical in terms of diverting energy to the productive traits rather than for adaptation in the NGS zone of Nigeria.

Table 1: Fluctuations in the mean (± SEM) thermal environmental parameters during the hot-dry season in the study microenvironment, Shika, Zaria, Nigeria

Meteorological Parameters	Morning (07:00 h)	Afternoon (14:00 h)	Evening (18:00 h)
Ambient temperature (°C)	30.25 ± 0.77^{a}	38.33 ± 1.13^{b}	34.83 ± 1.68^{ab}
Relative humidity (%)	48.83 ± 4.39^{a}	21.33 ± 3.67^{b}	25.67 ± 3.41^{b}
THI	78.45 ± 1.20	82.17 ± 0.59	79.55 ± 1.58

^{a,b}= Means in the same raw with different superscript are significantly ($P < 0.05$) different.

Table 2: Effect of perparturient period on rectal temperature (°C) in SH and WAD goats during the hot-dry season in Shika, Zaria, Nigeria

Morning (07:00 h)	Prepartum week 3	Prepartum week 2	Prepartum week 1	Postpartum week 1	Postpartum week 2	Postpartum week 3
SHG	39.15 ± 0.07^{y}	$38.63 \pm 0.08^{a,x}$	38.97 ± 0.06	38.91 ± 0.16^{a}	38.84 ± 0.06	38.96 ± 0.09
WAD	39.08 ± 0.06^{y}	$38.08 \pm 0.08^{b,x}$	38.82 ± 0.12^{y}	$39.37 \pm 0.11^{b,y}$	39.21 ± 0.14^{y}	39.20 ± 0.07^{y}
Afternoon	(14:00)					
SHG	39.37 ± 0.05	39.02 ± 0.08	38.96 ± 0.06	39.34 ± 0.11	39.00 ± 0.17	39.34 ± 0.18
WAD	39.73 ± 0.04^{x}	39.54 ± 0.08^{y}	39.27 ± 0.09^{y}	$39.66 \pm 0.07^{x,z}$	$39.31 \pm 0.11^{y,z}$	39.40 ± 0.10^{y}

^{a,b,c} = Means in the same column with different superscripts are significantly different ($P < 0.05$);
^{x,y,z} = means in the same raw with different superscripts are significantly ($P < 0.05$) different

WAD = West African Dwarf goat; SHG = Sahel goat

Table 3: Effect of perparturient period on respiratory rate (breaths/min) in SH and WAD goats during the hot-dry season in Shika, Zaria, Nigeria

Morning (07:00 h)	Prepartum week 3	Prepartum week 2	Prepartum week 1	Postpartum week 1	Postpartum week 2	Postpartum week 3
SHG	36.40 ± 1.83[a,y]	30.40 ± 1.71[y]	35.00 ± 2.22[a,y]	46.20 ± 3.43[a,x]	40.20 ± 3.13[a]	38.00 ± 3.17[a]
WAD	49.80 ± 2.24[b,y]	40.00 ± 2.07[y]	51.20 ± 5.12[b,y]	77.80 ± 4.55[b,x]	56.00 ± 4.13[b,y]	52.00 ± 4.42[b,y]
Afternoon (14:00 h)						
SHG	40.00 ± 1.89[x]	41.80 ± 1.47[a,y]	42.40 ± 2.25[a,y]	49.60 ± 3.05[a]	41.20 ± 3.38[a]	38.00 ± 2.02[a]
WAD	48.00 ± 1.52[y]	78.00 ± 3.59[b,x]	60.40 ± 3.12[b,y]	78.40 ± 3.83[b,x]	55.60 ± 3.40[b,y]	61.20 ± 6.08[b,y]

[a,b,c] = Means in the same column with different superscripts are significantly different ($P < 0.05$); [x,y,z] = means in the same raw with different superscripts are significantly ($P < 0.05$) different
WAD = West African Dwarf goat; SHG = Sahel goat

CONCLUSION

It was concluded that the WAD goats had higher mean RT and RR at the afternoon hour (14:00 h) in comparison to SHG during the prepartum and postpartum period. Therefore, WAD goats were able to maintain RT within the normal physiological range in a novel environment of the NGS zone of Nigeria at the expense of increased RR. Special management care should be provided to the periparturient WAD to shield them from excessive exposure to heat stress during the hot-dry season and especially, the early phase of lactation.

REFERENCES

Habibu, B., Kawu, M.U., Makun, H.J., Aluwong, T. and Yaqub, L.S. (2016). Seasonal variation in body mass index, cardinal physiological variables and serum thyroid hormones profiles in relation to susceptibility to thermal stress in goat kids. *Small Ruminant Research*, 145: 20-27.

Habibu, B., Kawu, M.U., Makun, H.J., Aluwong, T., Yaqub, L.S., Ahmad, M.S., Tauheed, M. and Buhari, H.U. (2014). Influence of sex, reproductive status and foetal number on erythrocyte osmotic fragility, haematological and physiologic parameters in goats during the hot-dry season. *Veterinarni Medicina*, 59(10): 479-490.

Hamzaoui, S.A.A.K., Salama, A.A.K., Albanell, E., Such, X. and Caja, G. (2013). Physiological responses and lactational performances of late-lactation dairy goats under heat stress conditions. *Journal of Dairy Science*, 96(10): 6355-6365.

Lawal-Adebowale, O.A. (2012). Dynamics of ruminant livestock management in the context of the Nigerian agricultural system. *Livestock Production*, 4: 1-20.

Makun, H.J., Abdulganiyu, K.A., Shaibu, S., Otaru, S.M., Okubanjo, O.O., Kudi, C.A. and Notter, D.R. (2020). Phenotypic resistance of indigenous goat breeds to infection with Haemonchus contortus in northwestern Nigeria. *Tropical Animal Health and Production*, 52(1): 79-87.

Minka, N.S. and Ayo, J.O. (2016). Effects of cold-dry (harmattan) and hot-dry seasons on daily rhythms of rectal and body surface temperatures in sheep and goats in a natural tropical environment. *Journal of Circadian Rhythms*, 14(1): 1-11.

Omontese, B.O., Rekwot, P.I., Ate, I.U., Ayo, J.O., Kawu, M.U., Rwuaan, J.S., Nwannenna, A.I., Mustapha, R.A. and Bello, A.A. (2016). An update on oestrus synchronisation of goats in Nigeria. *Asian Pacific Journal of Reproduction*, 5(2): 96-101.

Radin, L., Šimpraga, M., Vince, S., Kostelić, A. and Milinković-Tur, S. (2015). Metabolic and oxidative status of Saanen goats of different parity during the peripartum period. *Journal of Dairy Research*, 82(4): 426-433.

Ravagnolo, O., Misztal, I. and Hoogenboom, G. (2000). Genetic component of heat stress in dairy cattle, development of heat index function. *Journal of Dairy Science*, 83(9): 2120-2125.

Salama, A.A., Hamzaoui, S., Albanell, E., Such, X. and Caja, G. (2021). Metabolic and behavior responses of lactating goats under heat stress. *Small Ruminant Research*, https://doi.org/10.1016/j.smallrumres.2021.106496

Salama, A.A.K., Caja, G., Hamzaoui, S., Badaoui, B., Castro-Costa, A., Façanha, D.A.E., Guilhermino, M.M. and Bozzi, R. (2014). Different levels of response to heat stress in dairy goats. *Small Ruminant Research*, 121(1): 73-79.

Timveh, J.T., Yakubu, A. and Alu, S.E. (2022). Effects of breed and sex on the adaptive profile of tropical goats. *Acta fytotechnica et zootechnica*, https://doi.org/10.15414/afz.2022.25.01.24-33

Yaqub, L.S., Ayo, J.O., Habibu, B., Lawal, M., Kawu, M.U. and Rekwot, P.I. (2021). Thermoregulatory, oxidative stress and lipid responses in prepartum ewes administered with L-carnosine during the hot-dry season. *Tropical Animal Health and Production*, 53(3): 1-10.

62 GROWTH PARAMETERS OF RATS FED VARYING RATIONS OF EDIBLE CHITOSAN-STARCH FILMS PACKAGING

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Abstract
This study aimed at assessing the growth parameters of rats fed varying rations of edible chitosan-starch films supplemented diets. Commercial rat diet was supplemented with 5 – 40 % rations of chitosan-starch films. Twenty-five rats were randomised into five groups and fed the supplemented diets for a period of 28 days. Proximate composition of chitosan, edible chitosan-starch films and chitosan-starch film supplemented diets were determined using the AOAC methods. Weekly feed intake, weekly weight-gain and organ weight ratios were determined. Histopathology of the liver, kidney and intestine were carried out. Chitosan was significantly ($p<0.05$) lower in all proximate components except for carbohydrate and fibre, chitosan-starch film was significantly higher in moisture, fat and ash compared to the supplemented diet and the control. Rats placed on 5 % edible chitosan-starch film had the highest feed intake and weight gain while those placed on 40 % had the least. The kidney and intestine body-weight ratios were significantly ($p<0.05$) lower in the rats on the supplemented diets compared to the control, not different in the liver body-weight ratio. The liver showed normal intact hepatic cells, while the kidney and intestine showed degeneration of the glomeruli, capsular space, and connective tissue inflammation in rats fed diets above 5 % of edible chitosan-starch film. This study suggests that edible chitosan-starch films may be toxic to albino rats at levels higher than 5 % diet inclusion.

INTRODUCTION

Chitosan-based edible films are increasingly being used for food packaging. Chitin is converted into chitosan after de-acetylation. It is a D-glucosamine and N-Acetyl-D-glucosamine linear amino polysaccharide, and its solubility in acetic and hydrochloric acids helps it form films (Mitelut *et al*., 2015). Chitosan-based films are produced from a combination of lipids, proteins, polysaccharides, and proteins (Han, 2014), appropriate modifications to their features enhances their antibacterial, barrier, antioxidant, mechanical, optical, and thermal stability qualities. Edible chitosan films are commonly considered as a biodegradable, renewable polymers and are discovered to be digested and biodegradable with outsounding preservation properties, they are used to package a variety of foods like; meat, fruit, and vegetables. Although edible films are produced from natural resources the risk of prolonged usage is unknown (Douglas *et al*., 2015), there is however a dearth of literature on the histoarchitectural organ changes of rats fed edible chitosan-starch film supplemented diets.

OBJECTIVES

The objectives are:

- determine the proximate compositions of chitosan, edible chitosan-starch films and edible chitosan-starch film supplemented diets
- determine the feed intake and weight-gain of albino rats fed edible chitosan-starch film supplemented diets
- determine the organ-weight ratio of the liver, kidney and intestine of albino rats fed edible chitosan starch film supplemented diets
- determine the histopathology of the liver, kidney and small intestine of albino rats fed edible chitosan-starch films

MATERIALS AND METHODS

Source of Material

Chitosan was purchased from Beijing, Wisapple Biotech, Co., Ltd. Cassava was sourced from the Ultra-Modern Market Minna, Niger State, Nigeria

Experimental animals

Albino rats weighing between 80-100 g were purchased from Ahmadu Bello University animal house in Zaria, Nigeria. This experiment was approved by the Ethical Committee of the Federal University of Technology, Minna with Assign number 000033.

Starch extraction

Starch extraction from cassava tubers was carried out using the methods of Kaur et al., (2016) without modification.

Preparation of edible chitosan-starch films

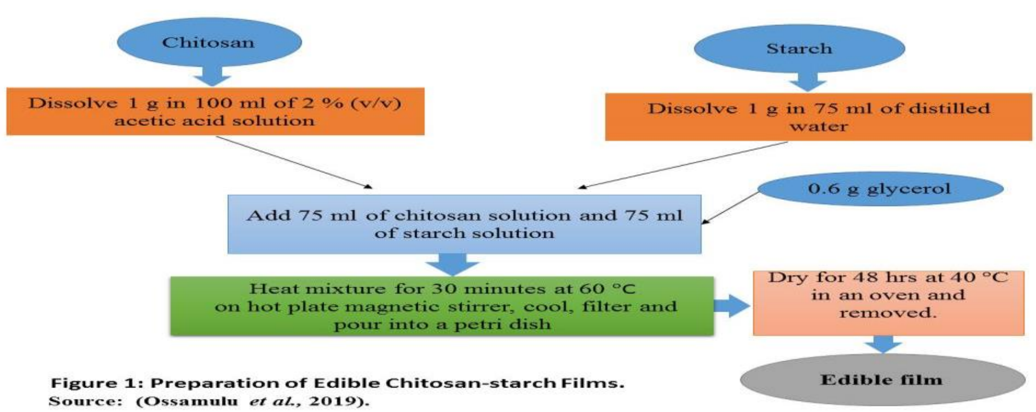

Figure 1: Preparation of Edible Chitosan-starch Films.
Source: (Ossamulu *et al.*, 2019).

Proximate composition

Proximate composition of chitosan, edible chitosan-starch film and chitosan-starch film supplemented diets were determined by the methods described by AOAC, (2012).

Histopathology

Histopathology was carried out as described by Fadia *et al*. (2022)

Data Analysis

All analyses in triplicate and were subjected to analysis of variance (ANOVA) followed by post-hoc Duncan test for comparison of the mean using SPSS version 23.0.

Results and Discussion

The proximate compositions of chitosan, edible chitosan-starch film and chitosan-starch film supplemented diets are shown in Table 1. The moisture content of edible chitosan-starch film was significantly (P<0.05) higher than the moisture content in chitosan. The supplemented diets were significantly (P<0.05) high in moisture content than the control diet. The higher the film supplemented in the diets, the higher the moisture content, the same trend was observed for ash and lipid content. However, a different pattern was observed for fibre, protein and carbohydrate contents. The higher the film supplemented in the diets the lower the fibre, protein and carbohydrate contents.

Figure 2 shows the feed intake by albino rats, the feed intake of the experimental rat groups and that of the control were not significantly different (P>0.05) at the first week, although there was a significant difference (P<0.05) in the feed intake at week 2, 3 and 4 of albino rats placed on the control and supplemented diets. Group B rats placed on 5 % film had the highest feed intake in all the weeks while group E rats placed on 40 % edible film had the least feed intake.

Figure 3 shows the body weight-gain, there was a significant change (P<0.05) in the weekly body weight-gain in the rats placed on the supplemented diets compared to those fed the control diets. Group B rats fed 5% edible chitostan-starch film had the highest body weight-gain in all the weeks.

Figure 4 shows the kidney body-weight ratio, liver body-weight ratio and intestine body-weight ratio of albino rats placed on edible chitosan-starch film supplemented diets. The result showed that there was significant difference (P<0.05) in the kidney body-weight ratio and in the intestine body-weight ratio. However, there was no significant difference (P>0.05) in the liver body-weight ratio of the albino rats.

Plate I – XV shows the histoarchitecture of the liver, kidney and intestine of rats placed on edible chitosan-starch film supplemented diets and those of the control. There was no change observed in the liver of rats placed on edible chitosan-starch film supplemented diets when compared to that placed on the control diet. There was a degeneration of the glomeruli, capsular space in the kidney and connective tissue inflammation in the intestine of rats fed the supplemented diet.

Table 1: Proximate Compositions of Chitosan, Edible Chitosan-Starch Film and Chitosan-Starch Film Supplemented Diets.

Parameters (%)	*Chitosan-starch film supplemented diets					Edible Chitosan-Starch Film	Chitosan
	A	B	C	D	E		
Moisture	9.67±0.17[a]	12.67±0.17[b]	14.17±0.44[c]	17.00±0.29[d]	17.33±0.73[de]	18.67±0.73[e]	11.00±0.00[a]
Ash	6.00±0.50[b]	7.50±0.29[c]	8.83±0.33[d]	11.67±0.73[e]	13.83±0.17[f]	12.33±0.33[e]	4.33±0.33[a]
Fat	10.10±0.29[b]	13.50±0.00[c]	14.33±0.44[cd]	15.33±0.44[d]	14.17±0.17[c]	25.33±0.44[e]	8.50±0.29[a]
Fibre	13.23±0.44[d]	8.00±0.29[b]	7.67±0.33[b]	6.33±0.17[a]	6.17±0.67a	7.50±0.00[b]	10.17±0.33[c]
Protein	13.73±0.12[e]	12.69±0.06[d]	12.45±0.10[cd]	12.28±0.00[c]	11.58±0.10[b]	0.82±0.06[a]	4.32±0.06[f]
Carbohydrate	47.27±0.20[d]	45.64±0.23[d]	42.55±1.17[c]	37.39±0.73[b]	36.92±0.41[b]	35.35±0.78[a]	61.68±0.34[e]

Values are Mean ± Standard Error of Mean of triplicate determinations.
Values with different superscripts between the samples are significantly different ($p<0.05$).
*A: Control (100% rat chow), B: 5% film, C: 10% film, D: 20% film, E: 40% film.

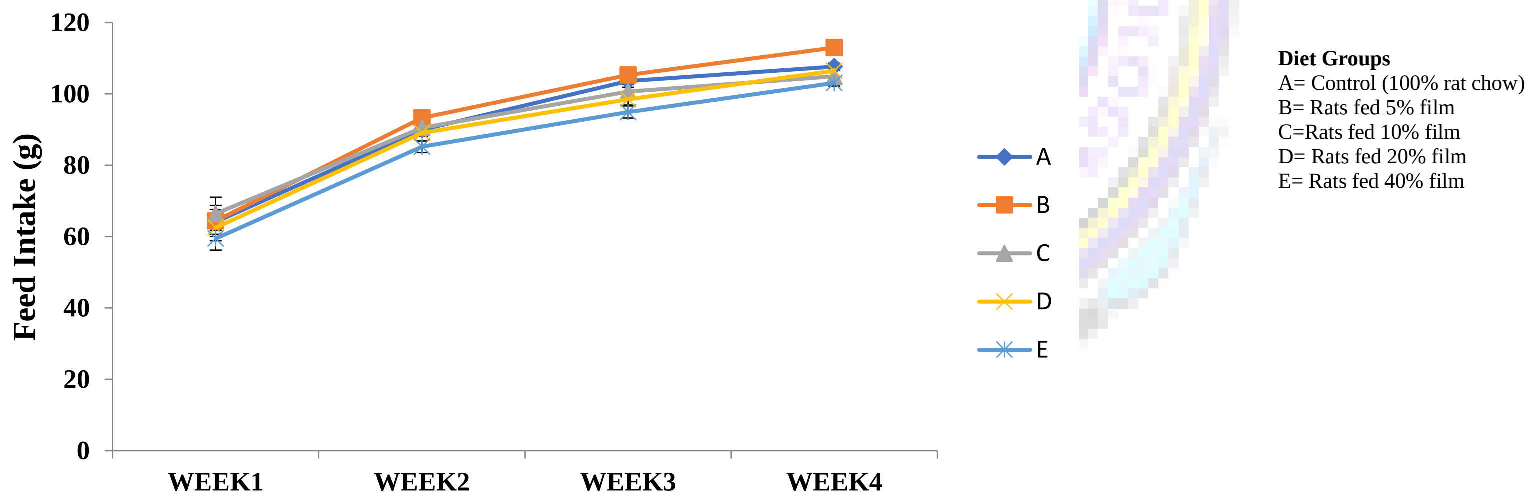

Figure 2: Feed intake by albino rats placed on edible chitosan-starch film supplemented diets.

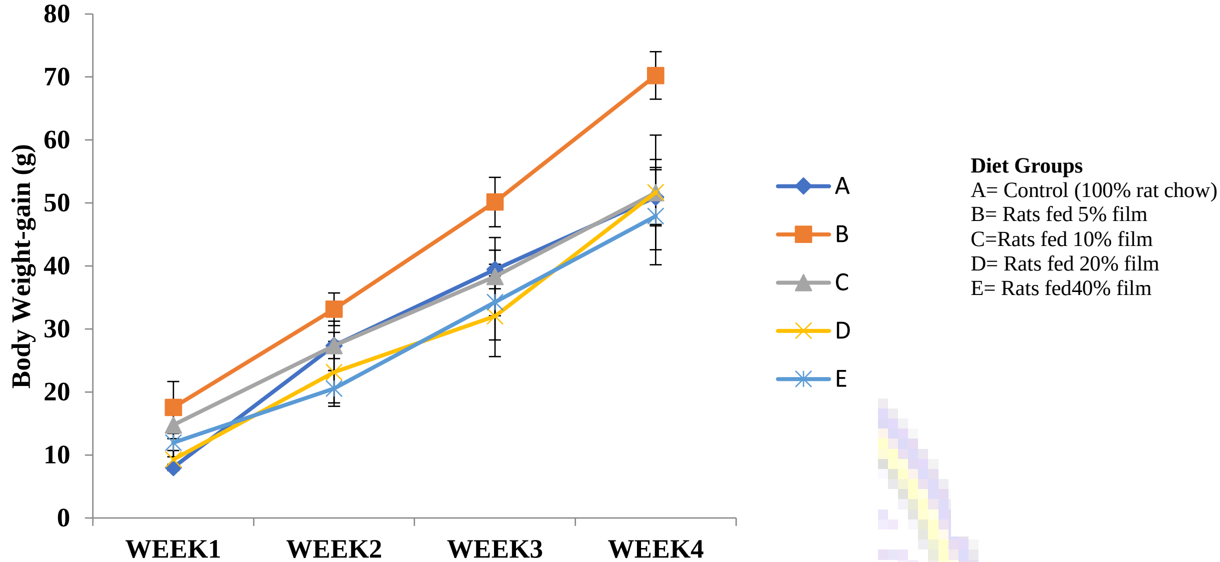

Figure 3: Body weight-gain of albino rats placed on edible chitosan-starch film supplemented diets.

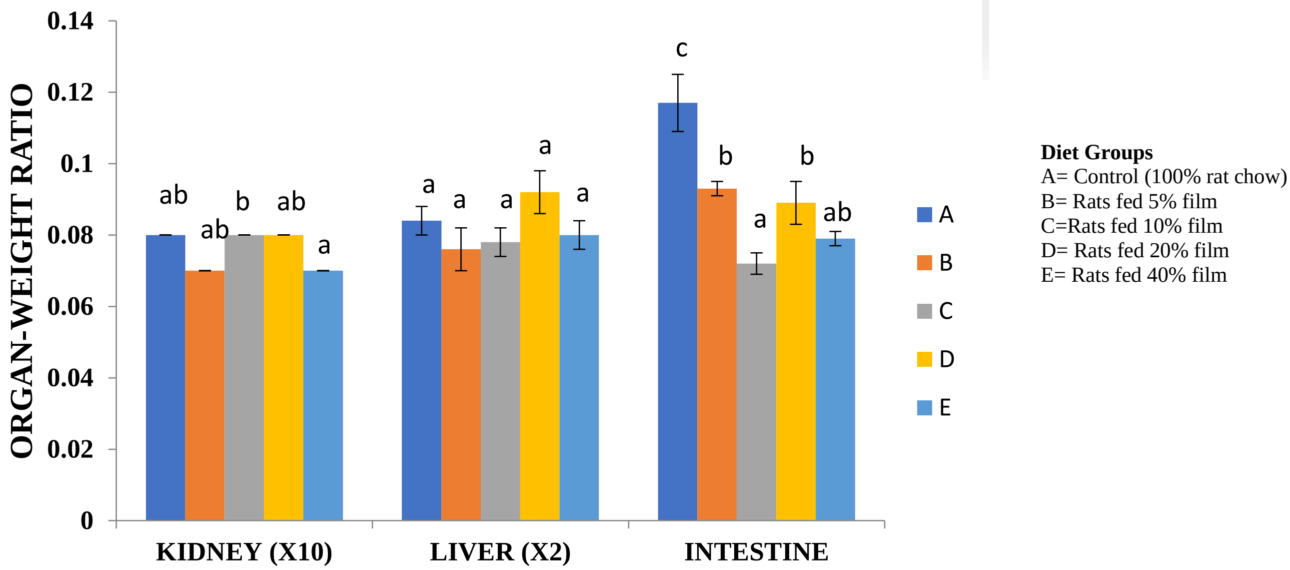

Figure 4: Organ-weight ratio of the kidney, liver and intestine of albino rats placed on edible chitosan-starch film supplemented diets.

LIVER

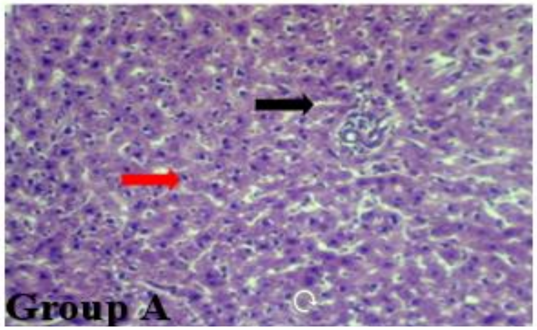

Plate 1: Photomicrograph of the Liver tissue showing normal histological architecture with intact hepatic cells

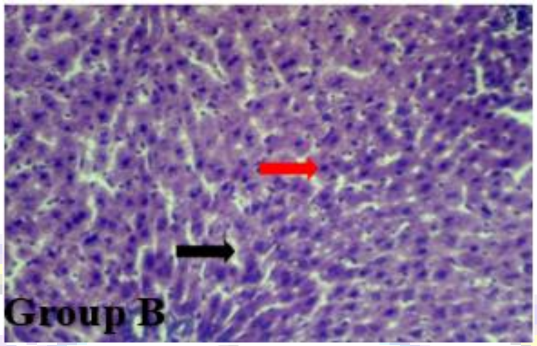

Plate 2: Photomicrograph of the liver tissue showing unaltered hepatic cell

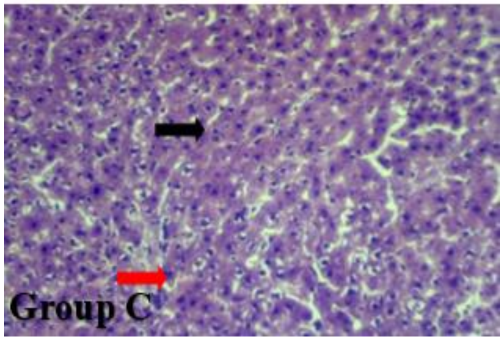

Plate 3: Photomicrograph of the Liver tissue showing unaltered hepatic cells

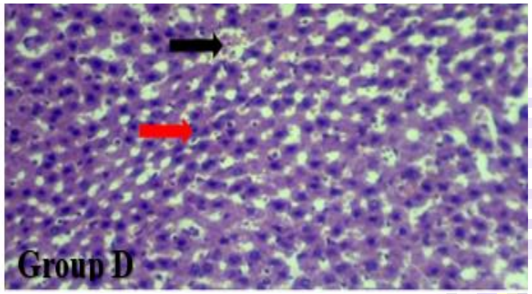

Plate 4: Photomicrograph of the Liver tissue showing normal histological features

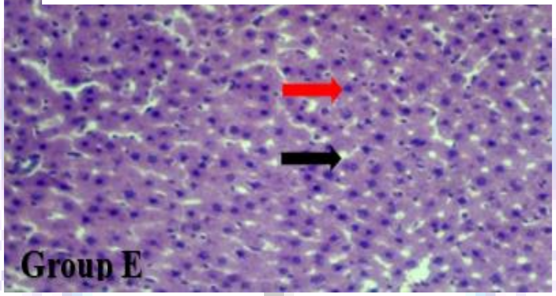

Plate 5: Photomicrograph of the Liver tissue showing unaltered hepatic cells

Plate 1-5: Photomicrograph of the Liver Tissue (Mg x 40; Eosin/Haematoxylin)
Black Arrow: Hepatocytes, **Red Arrow**: Hepatic sinusoids

KIDNEY

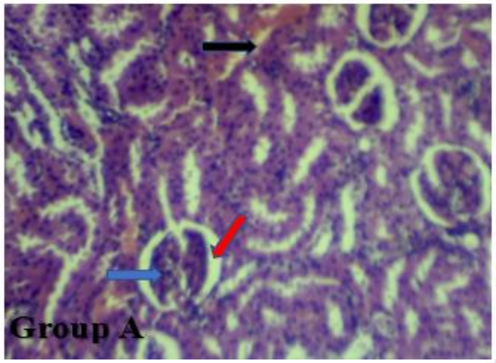

Plate 6: Photomicrograph of the kidney tissue showing normal histological architecture with intact glomeruli and capsular space.

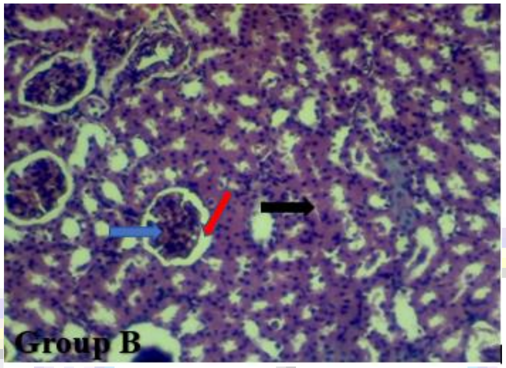

Plate 7: Photomicrograph of the kidney tissue showing normal glomeruli and capsular space.

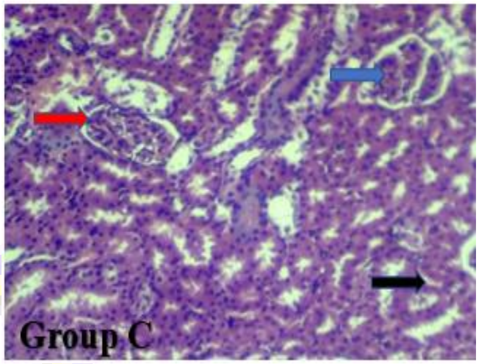

Plate 8: Photomicrograph of the kidney tissue showing normal capsular and glomeruli degeneration.

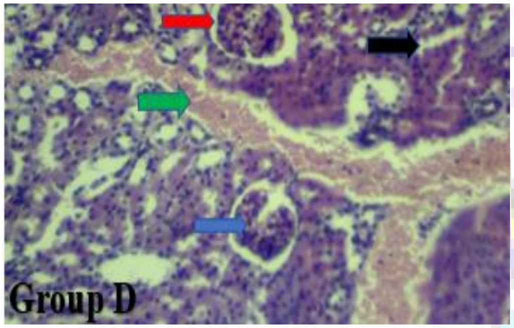

Plate 9: Photomicrograph of the kidney tissue showing normal capsular and

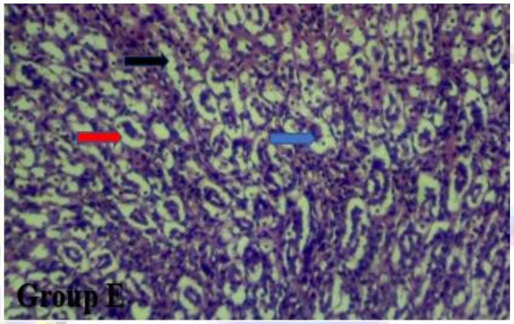

Plate 10: Photomicrograph of the kidney tissue showing degeneration of capsular

Plate 6-10: Photomicrograph of the Kidney Tissue (Mg x 40; Eosin/Haematoxylin)
Blue Arrow: Glomerulus, **Red Arrow**: Capsular space, **Green Arrow**: Area of Inflammation, **Black Arrow**: Distal convoluted tubules.

INTESTINE

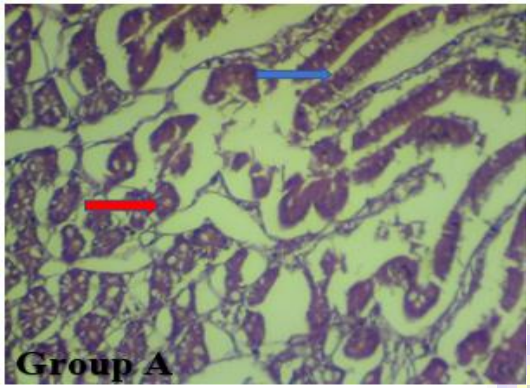

Plate 11: Photomicrograph of the intestinal tissue showing normal histological architecture with intact epithelial cells

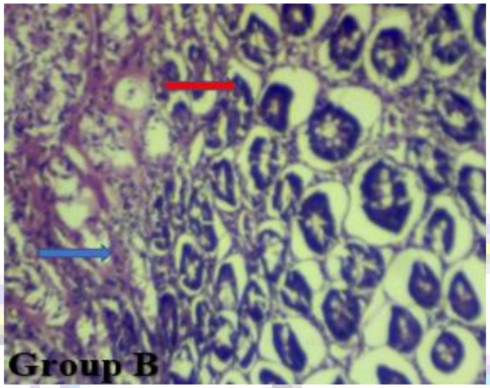

Plate 12: Photomicrograph of the intestinal tissue showing unaltered histological architecture.

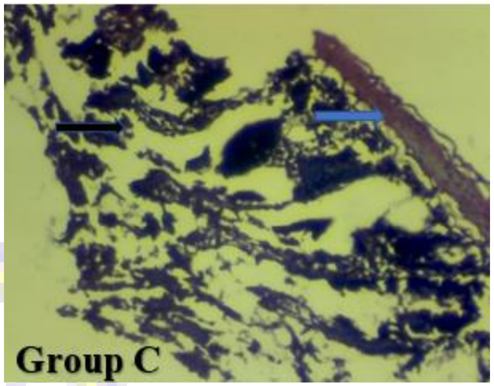

Plate 13: Photomicrograph of the intestinal tissue showing slight connective tissue degeneration.

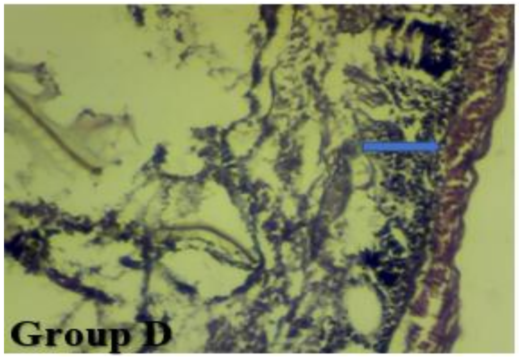

Plate 14: Photomicrograph of the intestinal tissue showing connective tissue inflammation.

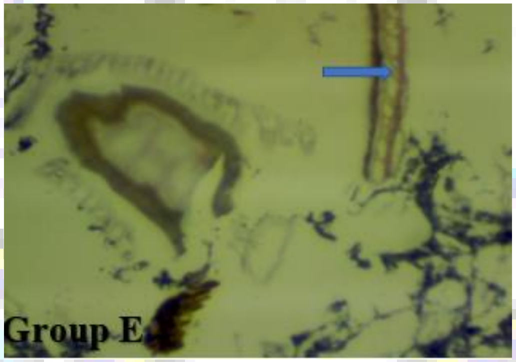

Plate 15: Photomicrograph of the intestinal tissue showing connective tissue inflammation.

Plate 11-15: Photomicrograph of the Instestine Tissue (Mg x 40; Eosin/Haematoxylin). Blue arrow: Smooth muscle fibre, Red arrow: Lamina propria (Connective tissue)

CONCLUSION

Chitosan was significantly lower in all proximate components except for carbohydrate and fibre, chitosan-starch film was significantly higher in moisture, fat and ash compared to the supplemented diet and the control. The kidney and intestine body-weight ratios were significantly lower in the rats on the supplemented diets. Group B rats placed on 5 % edible chitosan-starch film supplemented diets had the highest feed intake and weight-gain in all the weeks. Also, noticeable changes were observed in the histoarchitecture of the kidney and intestine of albino rats placed on diets supplemented with more than 5 % edible films, this was in agreement with our earlier report on its safety based on haematological and biochemical indices (Akanya *et al*., 2022). Therefore, edible chitosan-starch films may be considered toxic to albino rats at levels higher than 5 % diet inclusion.

References

Akanya, H.O., Okorie, M., Ossamulu, I.F., Egwin, E.C and Adefolalu, F.S. (2022). *In-vivo* Toxicological Evaluation of Edible Chitosan-starch Film for Food Packaging. International Society for Nutraceuticals and Functional Foods (ISNFF), *Functional Foods, Nutraceuticals, Natural Health Product and Dietary Supplements*, 2nd-5th October, 2022. Istanbul-Turkey, pg. 58.

AOAC, (2012). Official methods of analysis, Association of official analytical chemist 19th edition, Washington D.C., USA.

Douglas, R.J., Lorena, N.B., Thiago, B.L., Prando, L.F. and Martins, F.G. (2015). "Ninety-Day Oral Toxicity Assessment of an Alternative Biopolymer for Controlled Release Drug Delivery Systems Obtained from Cassava Starch Acetate", *Evidence-Based Complementary and Alternative Medicine*, 7.

Fadia, B.S., Mokhtari-Soulimane, N., Meriem, B., Wacila, N., Zouleykha, B., Karima, R., Soulimane, T., Tofail, A.M., Townley, H. and Thorat, N.D. (2022). Histological Injury to Rat Brain, Liver, and Kidneys by Gold Nanoparticles is Dose-Dependent. *ACS Omega*, 7(24), 20656-20665.

Han, H.D., Nam, D.E., Seo, D.H., Kim, T.W. and Shin, B.C. (2014) Preparation and biodegradation of thermosensitive chitosan hydrogel as a function of pH and temperature. Macromol Res 12:507–511

Kaur, K., Ahluwalia, P. and Singh, H. (2016). Cassava: Extraction of starch and utilization of flour in bakery products. Project: Tuber Crops. *Intl. J. Food. Ferment. Technol*. 6(2): 351-355.

Miteluț, A.C., Tănase, E.E Popa, V.L. and Popa, M.E. (2015). Sustainable Alternative for Food Packaging: Chitosan Biopolymer - A Review. *AgroLife Scientific Journal*, 4(2), 52-61.

63 EFFECT OF BREED AND SEX ON PELT GROWTH OF NEW ZEALAND WHITE AND CHINCHILLA GIGANTAS RABBITS

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Abstract

New Zealand White and Chinchilla Giganta rabbits are breeds of rabbits popularly known for their meat production and pet strain and usually produce top quality pelts when slaughtered. As the rabbits increased in sizes, so also are the pelt weight and pelt area which corresponded to the body volume and the vastness of the pelt. The research aim was to study the effect of breeds and sexes on the development of pelt. A total of 216 (54 males and 54 females of NZW; 54 males and 54 females of the Chinchilla Giganta) rabbits were used in this research. Data were analysed with analysis of variance using GenStat software and the pelt area was calculated using ImageJ analysis. Variables observed were pelt weights and pelt area. The results showed that sexes had no interaction on pelt area but the breed does, and as the rabbit's increases in age, so also the increase in pelt weight and pelt area.

KEYWORDS: Sex, Breed, Pelt, New Zealand White, Chinchilla, Rabbit

INTRODUCTION

New Zealand White (NZW) and Chinchilla Giganta rabbits are one of the most popular rabbit breeds in the world, known for their meat production and pet strain (Ozurlu *et al*., 2009; Galal *et al*., 1994). New Zealand White rabbit has a short, soft fly back and tight-set white fur in the pelt while the Chinchilla Giganta are grey in colour and produce a top quality pelt when slaughtered. However, their intensive meat rabbit production techniques are frequently incompatible with quality fur pelt production standards (Lebas *et al*., 1997). Although meat is the main goal of rabbit production, furs and pelts are by- products that are usually recovered from skins with no particular production constraints (Lebas *et al*., 1997). The New Zealand White and the Chinchilla Giganta rabbits has high-quality skins that are used in fur garments, trimming, medical and cosmetic research, and other applications (Taha *et al*., 2006). Several factors influence the characteristics of animal skins, including sex, seasonal variations, production system, and slaughtering ages (Taha *et al*., 2006; Lebas *et al*., 2007; Taha *et al*., 2017). Rabbit pelts have a low monetary value compared to other by-product of live animals (Lebas *et al*., 2007). Several studies have shown that several factors affect the properties of rabbit pelts, but there is a lack of evidence regarding the effect of breeds and sexes on the characteristics and development of New Zealand White and Chinchilla Giganta rabbit pelts. As a result, the purpose of this study was to investigate into the effect of breeds and sexes on the growth of the pelt of New Zealand White and Chinchilla Giganta rabbits.

MATERIALS AND METHODS

Two hundred and sixteen (216) rabbits of 108 (54 males and 54 females) New Zealand White (NZW) and 108 (54 males and 54 females) Chinchilla Giganta rabbits were used for this study. The two (2) strains of rabbits after slaughtering, were defured, and the weight (g) of the pelts were also recorded at various slaughtering ages (21, 28, 35, 42, 56, 70, 84, 112 and 140 days). The first cut was usually an incision at the hind feet, passing from one thigh to the other, then the skin was pulled off in one piece after which the skin will be opened up. The surface area was determined by spreading the pelt over a hard surface and the outline traced. The traced version was subjected to free draw and the surface area determined by means of image analysis (ImageJ).The area (sq.cm) of the pelts were recorded using ImageJ analytical software. The data generated were subjected to statistical analysis of variance using GenStat, 2020 version.

RESULTS AND DISCUSSION

The weight and area (cm^2) of the pelt of male and female New Zealand White rabbits at their respective slaughter ages (days) were presented in Table 1 and Figure 1. More so, the weight and area (cm^2) of the pelt of male and female Chinchilla Giganta rabbits at their respective slaughter ages (days) were presented in Table 2 and Figure 2. There were significant differences ($P< 0.001$) in the pelt area of male and female NZW rabbits, as the rabbits increased in age until day 42, when almost all the rabbits retained their mature pelt areas. Significant differences ($P<0.001$) were recorded in the breed against the sex and breed.sex of the chinchilla Giganta which were not significant ($P>0.05$). There was progressive linear increase in the pelt area of male and female Chinchilla Giganta between 21 – 140 days. The mean pelt area (995.8 cm^2) of the female Chinchilla Giganta was slightly higher than that of the male (994.3 cm^2), while the male (1071.6 cm^2) was higher than the female (1058.8 cm^2) in the New Zealand White rabbits.

As the rabbits (New Zealand White and Chinchilla Giganta) increased in sizes, so also are the pelt weight and pelt area which corresponded to the body volume and the vastness of the pelt. The vastness of the fresh pelt increased and matched with pelt weight because the rabbits' size (or weight) translated to a higher vastness of the pelt due to the accumulation of fat under the skin.

The results obtained in this study are at variance with the findings of Tao (1994), which stated that New Zealand White crossbreed rabbits weighing 3.43± 0.36 kg at day 105 had a pelt area of 1.197± 0.94cm^2. The result of this research is in line with the result of Maynard and Loosely (1969) which demonstrated that an increase in the weight of rabbits would be accompanied by an increase in rabbit pelt's area. The pelt area in this study was not affected by sex, but the pelt of male rabbits was significantly larger than the female rabbits in the New Zealand White. This could be because male rabbits are usually fed for meat and maintenance purpose only unlike the female rabbits that go through the process of reproduction and lactation. This result may explain the decrement of follicle density in the skins of male rabbits. However, previous studies showed that the fibre density was significantly higher in female rabbits than that of the male rabbits (Ozurlu *et al*., 2009; Tao, 1994), while the significant difference between the two sexes in this study were not in agreement with Yagci *et al*. (2006).

Table 1: Weekly mean pelt weight (g) and pelt area (cm^2) of female and male New Zealand White rabbits.

	Pelt weight			Pelt area		
Age (Days)	F	M	Mean (g)	F	M	Mean (cm^2)
21	69.2	66.3	67.7^b	789.7	809.4	799.6
28	86.0	78.1	82.1^b	1008.3	1013.0	1010.7
35	126.4	129.9	128.2^c	1109.7	1175.0	1142.4
42	192.5	197.8	195.2^d	1161.9	1138.6	1150.3
56	214.0	192.1	203.1^{de}	1126.8	1097.0	1111.9
70	222.9	230.0	226.6^e	1167.3	1172.1	1169.7
84	315.9	331.1	323.5^f	1109. 2	1191.7	1150.5
112	386.7	372.7	379.7^g	1222.0	1118.7	1170.4
140	367.3	462.6	415.0^h	1179.1	1258.0	1218.6
Mean	220.1	228.9	224.57	1097.1	1108.2	1102..7
LSD	Breed	Sex	Breed.sex	Breed	Sex	Breed.sex
	ns	ns	***	***	ns	ns
SEM	8.94	4.00	12.65	22.31	9.98	31.55
RMS	959.4			5974.0		

Table 2: Weekly mean pelt weight (g) and pelt area (cm^2) of female and male Chinchilla Giganta rabbits.

	Pelt weight (g)			Pelt area (cm^2)		
Age (Days)	F	M	Mean (g)	F	M	Mean (cm^2)
21	34.4	37.5	35.9	783.8	798.2	791
28	68.3	70.5	69.4	799.8	780.7	790.2
35	77.3	75	76.1	885.7	876.9	881.3
42	146.5	166.7	156.6	934	914.5	924.2
56	224.9	226	225.4	965.6	926.7	946.2
70	245.6	203.1	224.3	1015.8	1091.3	1053.6
84	237.8	230	237.4	1125.1	1119.4	1122.2
112	338.2	337	337.6	1196.7	1207.9	1202.3
140	384.7	394.8	389.7	1255.7	1233.1	1244.4
Mean	195.3	193.4	194.7	995.8	994.3	995
LSD	Breed	Sex	Breed.sex	Breed	Sex	Breed.sex
	***	ns	***	***	ns	ns
SEM	3.29	1.47	4.65	5.93	12.59	17.80
RMS	129.9			1901		

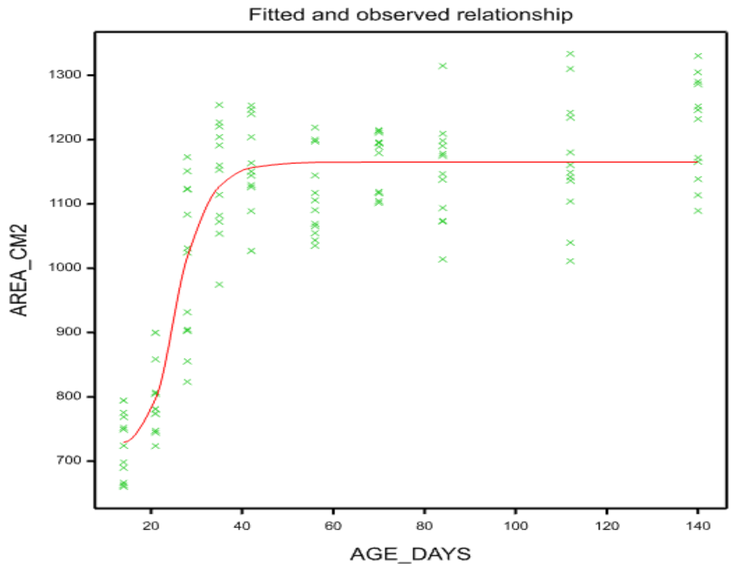

Figure 1: Fitted and observed relationship of the pelt area (cm^2) of male and female New Zealand White rabbits at their respective slaughter ages (days)

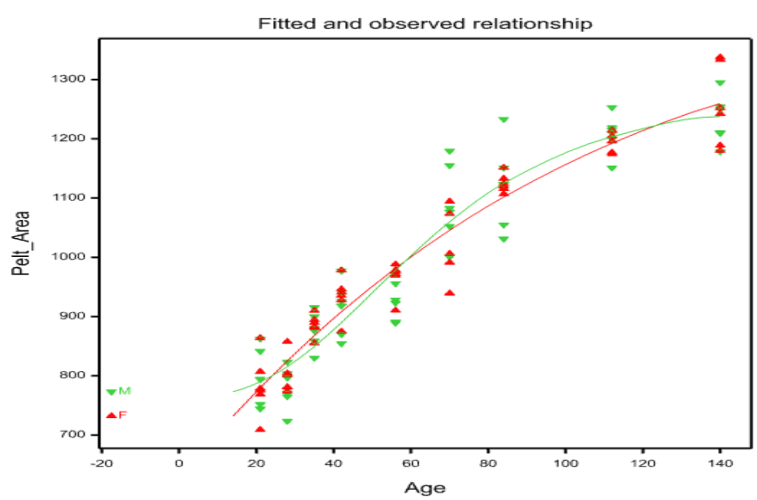

Figure 2: Fitted and observed relationship of the pelt area (cm^2) of male and female Chinchilla Giganta rabbits at their respective slaughter ages (days).

CONCLUSION

This current study showed a variation in the pelts developments due to breed and sexes of New Zealand White and Chinchilla Giganta rabbits. The findings highlighted that the mean pelt area was higher in the male than the female of the New Zealand White rabbits, while the pelt area of the female was higher than that of the male rabbits in the Chinchilla Giganta. This showed that the Chinchilla Giganta had higher pelt area than the New Zealand White rabbits.

REFERENCES

Galal, E.S.E. and Khalil, M.H. (1994). Development of rabbits industry in Egypt. *CHEAM-Options Mediterranean's*, 43-53.

Lebas, F. (2005). Rabbit Production in Tropical Zones. International rabbit symposium (2): 1- 9

Lebas, F., Coudert, P., de Rochambeau, H. and Thebault, R.G. (1997). The rabbit husbandry, health and production. *FAO, Rome, Italy*

Maynard and Loosely. (1969). Blood vessels and tissues space associated with the brain of the rat. *American Journal of Anatomy*

Ozurlu, Y., Celik, I., Sur, E., Telatar, T. and Ozparlak, H. (2009). Comparative skin histology of the White New Zealand and Angora rabbits; Histometrical and Immunohistochemical evaluations. *J. Anim. Vet. Adv*., 8: 1694-1701.

Taha, E.A., Hekal S.A. and Nasr, A.I. (2017). Evaluating skin quality of some rabbit breeds under Egyptian conditions. *World Rabbit Sci*. 25: 193-200.

Taha, E.A., Hekal, S.A. and Badawey, N.S. (2006). Studies of some skin and its coat characteristics in relation to feed additives of growing rabbits. *Egyptian J. of rabbit Sci*., 26(1): 105-119.

Tao, Y.R. (1994). Studies on the quality of Rex rabbit fur. *World Rabbit Sci*., 2:21-24.

Yagci, A., Zik, B., Uguz, C. and Altunbas, K. (2006). Histology and morphology of white New Zealand rabbit skin. *Indian Vet. J.*, 83 (8): 876-880.

64 WATER QUALITY ASSESSMENT OF THE PROPOSED KWADNA RESERVOIR WITHIN GIDAN KWANU MAIN CAMPUS, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGER STATE, NIGERIA

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Abstract

The study assessed the Water Quality parameters of the Kwadna Reservoir located at Federal University of Technology, Minna guided by the following objectives: determine the variation of the physico-chemical parameter across the months, the stations and to provide baseline data of the various physical and chemical properties of water. The Physico-chemical parameters of the river were studied for twelve weeks. Water samples was taken from five (5) stations in the reservoir, biweekly for the period of study. Samples collected was taken to the department of Water Resources, Aquaculture and Fisheries Technology (WAFT) laboratory for analysis. The results of the research depict that there was no significant variation in the mean values of physico-chemical parameters observed across the Station ($p>0.05$), pH range from 7.05±0.03 -7.36 ±0.03, Conductivity 281.5±45.5-311.7±44.9 µS/cm, Total alkalinity 115.7±22.0 -174.0±18.9, Total hardness 48.1±9.5-57.4±11.3mg/L, Calcium 17.3±5.4-24.6±4.6mg/L, Magnesium 4.0±2.4-8.6±2.9 mg/L, TDS 177.2±28.3-199.3±28.9mg/L,BOD 2.7±0.1-3.1±0.4mg/L, Dissolved oxygen 4.9±0.6-5.7±0.1mg/L, Carbon dioxide 1.7±0.9-3.4±2.3mg/L, BOD 2.7±0.1-3.1±0.4mg/L. Except Temperature and COD that has significant difference ($p<0.05$) range between 27.0±0.0-28.5±0.5^{0}C and 18.1±2.8-104.9±45.9 mg/L respectively. For monthly variations most parameters had significant difference ($p<0.05$) except Temperature and BOD that has no significant difference ($p>0.05$). Most of the physico-chemical parameters studied were within WHO range set standard for optimal fish production and survival. The mean temperature of the Reservoir (29.46°C) is in line with FAO (2006), which states that temperature requirements of 25^{0}C–30^{0}C is optimum for fish growth. This shows that temperature in the proposed Kwadna Reservoir is suitable to support the growth of fish Therefore, constant monitoring of the reservoir should be encouraged.

Keywords: Water Quality, Kwadna, Reservoir, Physico-chemical

INTRODUCTION

Water is one of the vital needs of all living beings. The quality of water usually described its physical, chemical and biological characteristics. Hence it becomes necessary to find out its the suitability for drinking, irrigation, fishing and Industrial purpose. The availability of good quality water is a necessary feature for preventing diseases and improving quality of life (Oluduro and Aderiye, 2007).

Dam reservoirs, which are an integral part of civilization development, have many features that distinguish them from natural lakes or rivers, hence they constitute a different category of surface water reservoirs. Their most important functions include water collection for municipal and agricultural purposes or flood protection. They are also used for recreational purposes, hydropower and fishing.

Water quality deterioration in reservoirs usually comes from excessive nutrient inputs, eutrophication, acidification, heavy metal contamination, organic pollution and obnoxious fishing practices. The effects of these “imports” into the reservoir do not only affect the socio-economic functions of the reservoir negatively, but also bring loss of structural biodiversity of the reservoir.

Water quality can generally be defined as chemical, physical and biological waters that are characteristic with respect to their suitability for a given use (Pawar, S.S, 2017). He further stated that the physico-chemical properties of water refer to the joint of physical characteristics and chemical composition of water body which include turbidity, colour, odour, temperature, pH, conductivity, dissolve oxygen (DO), Biological Oxygen demand (BOD), hardness, alkalinity, nitrate, chloride, CO_2, etc. Each of the designated uses has different definitions of the chemical, physical and biological standards needed to support the use.

These physiochemical compositions of water bodies need to be evaluated and compared with standards as a basis for the identification of the causes of the change in the water quality, high mortality or low population of aquatic animals in the dam reservoir.

Water quality parameters examined were pH, alkalinity, calcium, conductivity, magnesium, total hardness, Dissolved carbon dioxide, Chemical Oxygen Demand (COD) Total dissolved Solids (TDS), dissolved oxygen (DO), biochemical oxygen demand (BOD).

MATERIALS AND METHODS

Study area: The study was carried out at proposed Kwadna reservoir located within Federal University of Technology Minna, Bosso Local Government Area of Niger State, Nigeria which lies in between the latitude of 9^0 30' 40” N and longitude of 6^0 24' 50” E in the northern guinea savannah vegetation zone of Nigeria.

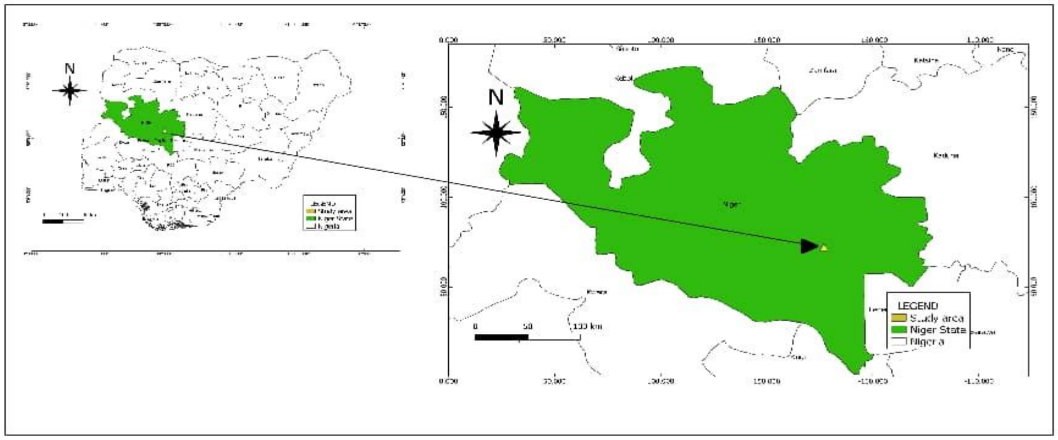

Figure 1: Nigeria indicating Niger State and the study area

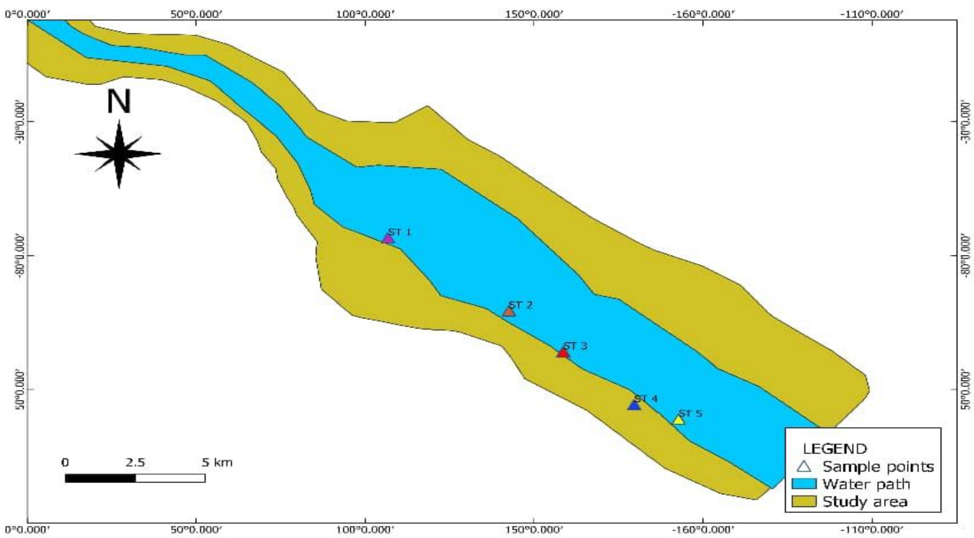

Figure 2: The study area indicating Sampling Stations

Sample collection and preparation: The samples were collected bi-weekly for three (3) months March, April, May from five different stations (Figure 2). Inlet of the Reservoir, open water of the reservoir bank of the reservoir were anthropogenic activities and opposite sides of the bank. The samples collected were analyzed for pH, Temperature, Alkalinity, Calcium, Conductivity, Magnesium, Total Hardness, Dissolved Carbon Dioxide, Chemical Oxygen Demand (COD) Total dissolved Solids (TDS), dissolved oxygen (DO), Biochemical Oxygen Demand (BOD).

Determination of pH: The pH of the water samples was determined using the pH meter. It was standardized with a buffer solution of pH range between 4, 7 and 9.

Measurement of temperature: This was carried out in-situ at the site of sample collection using a mobile thermometer. This was done by dipping the thermometer into the sample and recording the stable reading

Determination of conductivity: This was done using conductivity meter. The probe was dipped into the samples until a stable reading was obtained and recorded.

Determination of Alkalinity: 50mL of the sample was pipetted into a clean 250mL conical flask. Two drops of methyl red indicator were then added and the solution titrated against a standard 0.01M NaOH solution to a pink end-point. (American society for testing and Materials, 1982).
Total alkalinity (mg/L) = V x M x 50,000 / mL of sample used Where V = volume of acid used M = Molarity of acid used

Determination of total dissolved solids (TDS): by Gravimetric Method: A portion of water was filtered out and 10mL of the filtrate measured into a pre-weighed evaporating dish. Following the procedure for the determination of total solids above, the total dissolved solids content of the water was calculated. Total dissolved solids (mg/L) = (W2-W1) mg x 1000 mL of filtrate used. Where W1 = initial weight of evaporating dish W2 = Final weight of the dish (evaporating dish + residue).
Determination of Dissolved Oxygen: This was done using Winkler's method. Do bottle were used to collect the water sample at the sample site, 0.5ml of reagent 1(Magnose sulphate),and 0.5ml of reagent 2 (Potassium Hydroxide +Potassium Iodide) were added immediately into the collected sample,before it was transported to the laboratory.10ml of the sample was measured from the Do bottle into a conical flask,5drops of concentrated H_2SO_4 was added,5 drops of starch indicator was also added and was titrated with Sodiumthiosulphate until color changes from blue black colorations to colorless.
DO (mg/l) = TV×0.025×8×1000 20mls
Calculation DO (mg/L) = 16000 x M xV V2/V1 (V1-2) Where = Molarity of thiosulpahte used. V = volume of thiosulphate used for titration V1 =Volume of bottle with stopper V2 = Volume of aliquot taken for titration.

Determination of Biochemical Oxygen Demand (BOD): The method involves filling the samples to overflowing, in an airtight bottle of the specified size.

Determination of total Hardness: 25mL of the samples was placed in different clean 250mL conical flask. To this were added 3mL of ammonium chloride in concentrated ammonia buffer (NH4CL/conc.NH3) and 2 drops of Eriochrome Black T indicator. This was titrated against 0.01M

EDTA solution until there was a color change from violet to blue.

Calculation: Hardness in mg/L $CaCO_3$= V x M x 1000 mL of sample used Were M = Molarity of EDTA Used V =Volume of EDTA used

RESULTS AND DISCUSSIONS

Physico-chemical parameters Variation across the stations and months

The findings of the station variations deduce that some parameters had significant variation from each other while some had no significant variation. The mean temperature of the Reservoir recorded (29.46°C) is in line with FAO (2006), which states temperature requirements at the range of 25^0C – 30^0C is optimum for fish growth, Conductivity was higher during the month of March 385µS/m and lowest during the month of May this is as a result of increased water evaporation and emergence from wind while mean value of Dissolved oxygen of 5.19 mg/l obtained agree with Cline (2012) value of 3-10mg/L.

The mean BOD values of 2.91mg/l is in line with the work of Boyd (2003), which states that the optimal BOD values ranges between 3– 20 mg/l. Mean value of hardness was 53.91mg/l. indicate that the Reservoir water is a soft water which is within the desirable limit (WHO, 1984) that states hardness values below 300mg/l is potable water. For total Alkalinity the range value was 147.43mg/l this fell within the permissible range reported by Cline (2012), to be between 50-250mg/L suitable for fish growth.

The mean value for Calcium during the course of the research was 20.11mg/l and it fell within the permissible range as posited by WHO (1984), the maximum permissible limits for calcium in drinking water is 75mg/l. Thus the calcium level in this research is within the permissible limits. Though some parameters of the stations fall within the required range that support fish in the said period of March to May, some others are out of range which calls for greater attention to correct the causes to safeguard the future of fish survival in the Reservoir.

Table 1: Monthly variations of physico-chemical parameters of Proposed Kwadna reservoir

Parameters	March	April	May
pH	7.34±0.02[a]	7.05±0.03[b]	7.36±0.03[a]
Temperature (°C)	28.5±0.5 [a]	27.0±0.0 [a]	28.0±0.0 [a]
EC (µS/cm)	346.5± 10.84 [a]	336.80±10.63[a]	206.60±6.40[b]
TDS (mg/l)	216.00±9.67[a]	215.30±6.83[a]	132.00±3.98[b]
Alkalinity(mg/l)	162.50±12.49 [b]	156.60±8.72 [a]	118.20±18.35 [a]
Hardness (mg/l)	67.69±4.43 [a]	61.24±1.11 [a]	32.77±1.62[b]
Calcium (mg/l)	20.75±2.58[a]	26.32±2.01[a]	13.66±0.72[b]
Magnesium(mg/l)	12.85±1.17[a]	2.87±0.95[b]	4.03±0.57[b]
DO (mg/l)	4.70±0.29[b]	5.12±0.17[b]	5.19±0.09[a]
DCO2 (mg/l)	5.28±0.83[a]	1.59±0.14[b]	1.08±0.20[b]
BOD (mg/l)	2.71±0.13[a]	2.96±0.13[a]	3.08±0.21[a]
COD (mg/l)	58.24±27.27[a]	23.73±6.84 [b]	59.20±11.87[a]

Mean in the same row followed by the same superscript are not significantly different (P>0.05)
Mean not followed by the same superscript are not significantly different (P<0.05)

Table 2: Stations variation of physico-chemical parameters of Proposed Kwadna reservoir

Parameters	Station 1	Station 2	Station 3	Station 4	Station 5
Ph	7.26±0.0[a]	7.31±0.09 [a]	7.25±0.12 [a]	7.23±0.12 [a]	7.20±0.11 [a]
Temperature (°C)	28.5±0.5 [b]	27.0±0.0 [a]	28.0±0.0 [a]	28.2±0.0 [b]	27.5±0.5 [a]
EC (µS/cm)	297.3±51.1 [a]	311.7±44.9[a]	291.8±49.7[a]	299.8±41.0 [a]	281.5±45.5 [a]
TDS (mg/l)	189.8±32.8 [a]	199.3±28.9[a]	177.2±28.3[a]	191.8±26.3 [a]	180.7±29.1 [a]
Alkalinity(mg/l)	174.0±18.9 [a]	123.5±22.5[a]	162.3±17.9[a]	161.7±6.4 [a]	115.7±22.0 [a]
Hardness (mg/l)	57.4±11.3 [a]	53.8±13.5 [a]	54.9±20.6 [a]	55.4±10.8 [a]	48.1±9.5 [a]
Calcium (mg/l)	18.9±3.0 [a]	19.3±4.2 [a]	20.5±4.1 [a]	24.6±4.6 [a]	17.3±5.4 [a]
Magnesium(mg/l)	8.6±2.9 [a]	6.5±4.3 [a]	6.9±2.5 [a]	4.0±2.4 [a]	6.9±3.8 [a]
DO (mg/l)	5.1±0.4 [a]	4.9±0.6 [a]	5.1±0.2 [a]	5.1±0.3 [a]	5.7±0.1 [a]
DCO2 (mg/l)	1.7±0.9 [a]	3.4±2.3 [a]	2.3±0.8 [a]	2.7±1.2 [a]	3.0±1.5 [a]
BOD (mg/l)	3.1±0.4 [a]	2.9±0.1 [a]	2.7±0.1 [a]	3.0±0.3 [a]	2.9±0.2 [a]
COD (mg/l)	50.9±11.0 [ab]	18.1±2.8[b]	35.2±17.6 [ab]	26.1±2.3 [b]	104.9±45.9 [a]

Mean in the same row followed by the same superscript are not significantly different (P>0.05)
Mean not followed by the same superscript are not significantly different (P<0.05)

Conclusion

The study on the assessment of physic-chemical parameters of Proposed Kwadna dam reservoir, Minna, Gidan Kwano Niger State was carried out bi-weekly for the period of three months in order to provide baseline information on the ecological status of the Reservoir. The physico-chemical parameters of the Reservoir varied with months and stations. The variations may be due to change in weather cycle during the study period.

REFERENCES

Boyd C.E (2003) Guildelines for aquaculture effluent management at the farm-level. Aquaulture 226:101-112.https://doi.org/10.1007/978-3-319-17446-4

Cline, D. (2012). Water quality in aquaculture. *Freshwater Aquaculture, Alabama Cooperative Extension System, Auburn University*.

Food and Agricultural Organization FAO (2006):The state of the worlds land and water resources for food and agriculture. Stakeholder oriented valuation to support water resource management pp 71 https://www.fao.org

Oluduro AO., Aderiye BI. (2007). Effeciency of moringa Oleifera seed extract on the microflora of surface and ground water. *Journal of Plant Sciences.* 6:453-438

Pawar, S. S. (2017). Analysis of some physicochemical parameters and their effect on the productivity of fishes in two different types of aquatic bodies of Unamganon and Seipargaon of Patharkandi block of Karimaganj district, Assam, India. *International Journal of Life Sciences*, 5(4): 587-592

World Health Organisation, (2011). Guidelines for drinking-water quality - 4th ed. ISBN 978 92 4 154815 1 World Health Organization, Geneva 27, Switzerland. Accessed July 2019. http://www.who.int

65 PHYLOGENY BETWEEN *CLARIAS GARIEPINUS* AND *HETEROBRANCHUS BIDOSALIS* INFERRED FROM SINGLE NUCLEOTIDE POLYMORPHISMS (SNPS) DNA MARKERS

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ABSTRACT

The phylogeny between Clarias gariepinus and Heterobrachus bidosalis species collected from three water bodies in Minna, Niger State, Nigeria, was carried out using SNPs DNA markers. SNPs growth-related gene primer was used for genotyping the DNA. All the samples from the three water bodies show the presence of the growth gene, two samples of each species from the various sampling sites were sequenced, and the UPGMA dendrogram was constructed from the sequence data. The UPGMA dendrogram (Bioedit) divides the population into main clades, the first clade consists of Clarias gariepinus, and the second clade consists of Heterobranchus bidosalis from three different water bodies; the two main clades indicate that both species are evolutionarily distant apart. The dendrogram reveals the genetic distance between Clarias gariepinus and Heterobranchus bidosalis reaffirming the taxonomic placing of the species in different species and genera.

KEYWORDS: Phylogeny; SNPs DNA markers; *Clarias gariepinus*; *Heterobrachus bidosalis*; Sequencing

INTRODUCTION

Clarias and *Heterobranchus* species are commonly referred to as catfish, they are the most important aquaculture fish in Nigeria because they are the most cultured species, and the development of aquaculture in Nigeria is based on their production (Adewumi and Olaleye, 2011). They are widely distributed across Africa, with their total global production reaching 246,476 tonnes in 2015 and increasing annually (FAO, 2017). Nigeria took second position after Malaysia as the catfish producing country, with a total production of 160,295 tonnes in 2015 (FAO, 2017). DNA marker is a DNA sequence used to mark or track a particular location (locus) on a specific chromosome or marker gene. It is a gene with a known location or clear phenotypic expression detected by analytical methods or an identifiable DNA sequence that facilitates the study of the inheritance of a trait or a gene (Okumu and Ciftci, 2003). Single nucleotide polymorphisms (SNPs) marker is a single base change or base variation among individuals at any point in a DNA sequence. Single nucleotide polymorphisms (SNPs) are co-dominant, lack ambiguity, and very useful in scanning large and disparate regions of the genome due to their abundance in both coding and non-coding regions of the genome (Williams *et al*., 2010). Genetic data improve or even allow the elucidation of phylogeny and provide the basic knowledge for understanding taxonomy, domestication, and evolution (Nwakanma *et al*., 2003). As a result, information from molecular markers or DNA sequences offers a good basis for better conservation approaches. The genetic information and evolutionary relationship between these valuable species for management and conservation are scarce; thus, this research will investigate the evolutionary relationships between *Clarias gariepinus* and *Heterobranchus bidosalis*.

MATERIALS AND METHODS

Sample collection: For the SNPs genotyping, ten samples of *C. gariepinus* and *H. bidosalis* were collected from three water bodies, namely Agaie/Lapai dam reservoir, Shiroro dam reservoir and Tagwai dam reservoir in Minna, Niger State, Nigeria and two samples of *C. gariepinus* and *H. bidosalis* were collected from the same three sampling sites with the help of fishermen were used for the sequencing. For the sampled fish for the experiment, the caudal fin was clipped into the well-labelled micro tube and stored at -17^{0}C in the refrigerator until used.

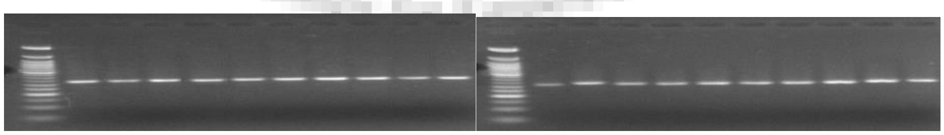
Extraction, purity, and quantification of genomic DNA: Quick-DNA^{TM} Miniprep Plus kit protocol was used to extract the genomic DNA from the caudal fin, revised 2021(www.zymoresearch.com), the guidelines were followed step by step with few modifications. The purity of the genomic DNA extracted was determined by measuring the optical density at 260nm to the optical density at 280nm to be 1.7-2.0 using a Nano-drop spectrophotometer. The genomic DNA was quantified by electrophoresis using 1% agarose gel buffered with 0.5x TBE at 80 volts for 1.5 hours and stained with 5µl ethidium bromide. The gel image was viewed under UV light (thermos scientific, UAS), captured, and stored in the computer. 200µl DNA was extracted from each sample and stored at -17^{0}C before being used for SNPs genotyping. These were carried out at the Bioscience center of the International Institute of Tropical Agriculture (IITA) in Ibadan, Nigeria.

SNPs genotyping, electrophoresis, and sequencing: The SNPs genotyping was carried out using growth-related gene SNPs primers, the genotyping reaction contained 2.5µl of 10x PCR buffer,1µl of 25mM $MgCl_2$, 1µl each of forward and reverse primers, 1µl of DMSO, 2µl of 2.5mM DNTPs, 0.1µl of 5ng/µl Tag DNA polymerase and 3µl of 10ng/µl DNA, the total reaction volume was made up to 25µl using 13.4µl Nuclease free water. The electrophoresis of the genotyped products was conducted using 2% agarose gels buffered with 0.5x TBE at 80 volts for 1.5hrs and stained with 5µl ethidium bromide; the gel image was viewed under UV light (thermos scientific, USA), captured and stored in the computer. The gel image revealed the presence of the growth-related gene in the sampled fish. The sequencing was carried out using the protocol for BigDye terminator v 3.1 cycle sequence kit in an automated sequencing machine (ABI 3500). The sequencing amplification reaction contained 0.5 µl of BigDye sequencing buffer, 1.0 µl of Buffer, 2.0 µl of PCR product, 1.0 µl of primer, and 5.5 µl of deionized water. These were carried out at the Bioscience center of the International Institute of Tropical Agriculture (IITA) in Ibadan, Nigeria. The sequence products were saved in a sequencing machine, then downloaded, edited, and aligned using BioEdit software. The phylogenetic tree (dendrogram) was drawn using BioEdit software and viewed using treeviewX software.

RESULTS AND DISCUSSION

SNPs genotyping products generated using SNPs growth-related gene obtained from GenBank (https://www.ncbi.nlm.nih.gov) with accession number Af416488.1 to reveal the growth gene of *Clarias gariepinus* and *Heterobranchus bidosalis* from three water bodies as shown in plate 1-4. The primer shows bands in all the samples obtained for the experiment from the three water bodies, indicating high growth potential in our indigenous fish species when all other water quality parameters are optimum.

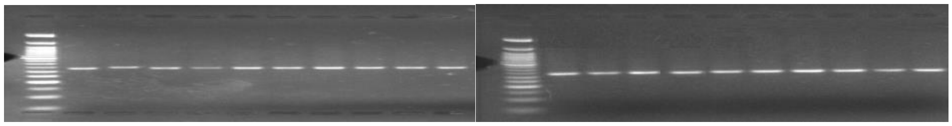
Phylogeny: The phylogeny between *Clarias gariepinus* and *Heterobranchus bidosalis* was constructed using the Unweighed Paired Group Method of Arithmetic Mean (UPGMA) dendrogram (BioEdit). The UPGMA dendrogram separates the two species into two main clades. The first clade comprises six (6) samples of Clarias gariepinus and the second clade includes six (6) samples of *Heterobranchus bidosalis*, as shown in fig.1.



M 1 2 3 4 5 6 7 8 9 10 M 1 2 3 4 5 6 7 8 9 10

Agaie/ Lapai samples Shiroro samples

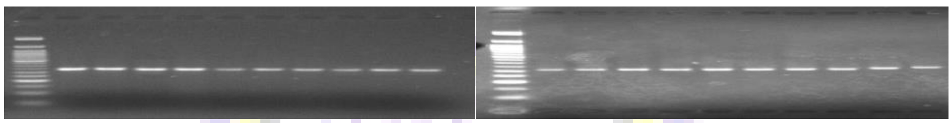
Plate 1: SNPs genotyping *Clarias gariepinus* SNPs genotyping *Clarias gariepinus*



M 1 2 3 4 5 6 7 8 9 10 M 1 2 3 4 5 6 7 8 9 10

Tagwai samples Agaie/Lapai samples

Plate 2: SNPs genotyping *Clarias gariepinus* SNPs genotyping *Heterobranchus bidosalis*



M 1 2 3 4 5 6 7 8 9 10 M 1 2 3 4 5 6 7 8 9 10

Shiroro samples, Tagwai samples

Plate 3: SNPs genotyping *Heterobranchus bidosalis* SNPs genotyping *Heterobranchus bidosalis*

Plate 1-3: SNPs genotyping of *Clarias garipinus* and *Heterobranchus bidosalis*, M: DNA ladder (50bp), and 1-10: fish samples.

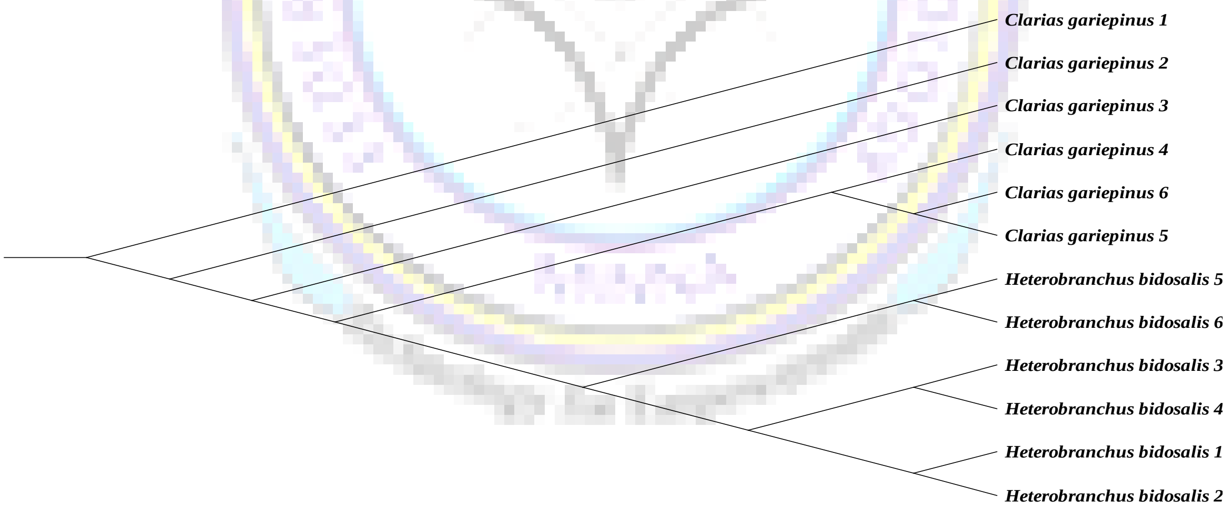


Fig 1: phylogenetic tree (dendrogram) between *Clarias garipinus* and *Heterobrachus bidosalis* from three water bodies, namely Agaie/lapai (1 and 2), shiroro (3 and 4) and Tagwai (5 and 6).

The UPGMA dendrogram (Bioedit) divides the population into main clades, the first clade consists of *Clarias gariepinus,* and the second clade consist of *Heterobranchus bidosalis* from three different water bodies. The two main clades indicate that both species are evolutionarily distant apart. The dendrogram also shows that Agaie/ Lapai samples are genetically closer to shiroro samples than Taqwai samples in both species. Tagwai samples are genetically closer to Shiroro than Agaie/Lapai samples in both species. The result of this research agrees with the report by Sokenu et al. (2020), who conducted a comparative study on *Oreochromis niloticus* and *Sarotherodon melanotheron* using the SNPs growth gene (IGF-I), revealing genetic distance between the two species. SNPs have gained recognition recently and are considered next-generation DNA markers in fisheries due to their abundance in many gene chips, which can be utilized in fisheries genomic studies and diagnosis of diseases (Okumus and ciftci, 2003).

CONCLUSION

In conclusion, the dendrogram reveals the genetic distance between *Clarias gariepinus* and *Heterobranchus bidosalis* reaffirming the taxonomic placing of the species in different species and genera.

REFERENCES

Adewumi, A.A., & Olaleye, V.F., (2011). Catfish culture in Nigeria: Progress, prospects, and problems. African Journal of Agricultural Research, 6(6), 1281-1285.

Food and Agriculture Organization of the United States (FAO). (2017). Fishery and Aquaculture Statistics. Global aquaculture production. In: FAO Fisheries and Aquaculture Department. Rome. https://www.fao.org/fishery/publications/yearbook/en

Nwakanma, D. C., Pillay M., Okoli B. E., & Tenkouano, A. (2003). Sectional relationships in the genus Musa L. inferred from the PCR-RFLP of organelle DNA sequences. Theory of Applied Genetics, 107, 850-856

Okumu, I., & Ciftci, Y. (2003). Fish population genetics and molecular markers. Turkish Journal of Fisheries and Aquatic Science, 3, 51-79.

Sokenu, B. A., Oguntade, O. R., Ogunkanmi, L. A., Oketoki, T. O., Ukenye, E. A., & Usman, A. B. (2020). Comparative study of single nucleotide polymorphisms (SNPs) of a candidate growth gene (IGF-I) in Oreochromis niloticus and Sarotherodon melanotheron. African Journal of Biotechology, 547-555.

Williams, L. M., Xin, M., Boyko, A. R., Bustamante, C. D., & Oleksiak, M. F. (2010). SNP identification, verification, and utility for population genetics in a non-model genus, BMC Genetics, 11-32. doi: 10.1186/1471-2156-11-32

66 EFFECTS OF PHOTOPERIOD AND FEEDING RATE ON THE GROWTH PERFORMANCE AND FEED UTILIZATION OF Clarias gariepinus

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Abstract

Effects of Photoperiod and feeding rate on the growth performance and feed utilization of Clarias gariepinus were investigated. Photoperiod and FR experiment was assigned as (1%, 3% and 5% body weight/night, 1%, 3% and 5%/night and day and 1%, 3% and 5% day respectively). Photoperiod (12D:12L) interaction with 5% feeding rate will allow for high feed utilization and growth rate (3.05%/day).

Keywords: specific growth rate, protein efficiency ratio, specific growth rate, feed conversion ratio, survival rate

Introduction

The culture of fish is becoming increasingly popular in Africa, this is due to the fact that fish is widely accepted as food and its hardy nature makes its culture relatively easy (Adebayo and Fagbenro, 2004). To improve on the culture of fish, there is a need for more information on the management method in the area of feed types (forms), feeding regimes (feeding rate and feeding rates) in relation to environmental factors in order to produce fish within the shortest possible time. *Clarias gariepinus* is a species of catfish of the family of Clariidae. It is an air-breathing catfish with omnivorous feeding habits. Catfish are known to have a high growth rate; being hardy; and being adapted to high-density holding (Romanova *et al.*, 2020).

Over and underfeeding could be detrimental to the health of the fish and may cause a marked deterioration in water quality; reduced weight; poor food utilization; and increased susceptibility to infection (Priestley *et al.*, 2006). This may also affect the specific growth rates and the efficiency of feed conversion as these have been observed to be directly related to feed ration and rate (Dwyer *et al.*, 2002). Therefore it is important to be able to predict the most favorable feeding rate relative to the species and size of fish. When fish are fed at a suitable feeding rate, growth and survival are expected to improve because this regulates their feed intake in relation to their energy demand (Schnaittacher *et al.*, 2005).

Photoperiod manipulation has been used successfully to improve the growth of some juvenile fish species (Simensen *et al.*, 2000; Biswas and Takeuchi, 2002). Continuous additional light has also been used on the Atlantic salmon reared in the sea cages, especially during the spring and winter to enhance growth and delay sexual maturation rate. Photoperiod manipulation applied in fish farming intends to increase the farming efficiency and get the fish to the commercial weight as soon as possible.

Growth is majorly dependent on the amount of feed that offers, essential nutrients and energy (Kaushik, 2013). Singh *et al.*, (2003) reported that percentage weight gain increased with the increase in feeding rates from 3 to 9% body weight per day. However, it was difficult to compare the results obtained in this study with those obtained in studies carried out for other fishes due to the differences in experimental conditions and methodology. Data supports that feeding fish to satisfaction would produce better output in comparison to a restrictive feeding rate (Li *et al.*, 2006).

Materials and Methods

The experiment on the effect of photoperiod and feeding rate on *Clarias gariepinus* was conducted at the National Institute for Freshwater Fisheries Research (NIFFR) in a controlled Laboratory. Water circulatory system equipped with Automated feeder was employed as a culturing medium. The system was constructed by Mechanical Engineering Department in collaboration with Water Resources, Aquaculture and Fisheries Technology Department, Federal University of Technology, Minna.

The size of the culture bowl is in diameter 12cm, Height 7cm is and circumference of 37.5cm.

The experiment comprises of nine (9) treatments in triplicate. Twenty fingerlings were stocked per bowl making a total of five hundred and forty (540). Initial weight of the fish were taken. Coppens fish feed was administered to the fish. The feeding rate used 1%, 3% and 5% and feeding period of Night, Night and day and day of factorial design 3 x 3 of a complete randomized.

Results

Table 1 depicts the effects of feeding rate and photoperiods on growth response and nutrient utilization of *Clarias gariepinus* fingerlings. There are significant differences ($p<0.05$) in the Mean Weight Gain (MWG), Specific Growth Rate (SGR), Feed Conversion Ratio (FCR), Protein Efficiency Ratio (PER), Apparent Nitrogen Protein Utilization (ANPU) and survival rate of the fish for all treatments. Treatment 9 has the highest growth response followed by treatments 6, 8, 3, 2, 5, 7, 4 and 1. Treatment 1 has the best feed efficiency in term of FCR (1.18g), PER (2.24g) and ANPU (109.50%).

Table 1: Growth Performance and Nutrient for Photoperiod and Feeding Rate of *Clarias Gariepinus*

Treatment	MIW	MFW (g)	MWG (%)	SGR (g)	FCR	PER	ANPU (%)	% (SURVIVAL)
1	7.41 ± 0.25	11.53 ± 0.43 f	4.10 ± 0.43 f	0.79 ± 0.09d	1.18 ± 0.13a	2.24 ± 0.16 a	109.50 ± 4.95a	85.00 ± 7.07 bc
2	7.54 ± 0.38	25.98 ± 0.57de	18.73 ± 0.75de	2.12 ± 0.12c	1.46 ± 0.12 bc	1.80 ± 0.06 b	77.00 ± 4.58 b	91.67 ± 2.89 ab
3	7.49 ± 0.37	28.29 ± 1.29 d	20.63 ± 0.96 c	2.18± 0.26 c	2.37 ± 0.48 a	1.20 ± 0.01 c	54.00 ± 2.83 c	90.00 ± 0.00 ab
4	7.57 ± 0.26	11.81 ± 0.36 f	4.28 ± 0.27 f	0.77 ± 0.03d	1.18 ± 0.08 bc	2.22 ± 0.14 a	82.00 ± 0.0 b	82.50 ± 3.54 bc
5	8.69 ± 0.08	24.16 ± 1.03 e	16.71 ± 0.04 e	1.82± 0.03 d	1.49 ± 0.01 bc	1.68 ± 0.02 b	76.33± 0.56 b	82.50 ± 3.54 bc
6	8.08 ± 0.16	41.36 ± 1.65 b	33.28 ± 1.43 b	2.83 ± 0.15ab	1.73 ± 0.13 b	1.52 ± 0.04 b	59.00 ± 3.00 c	97.58 ± 3.54 a
7	7.65 ± 0.15	12.17 ± 0.60 f	4.92 ± 0.14 f	0.83 ± 0.15 d	1.13 ± 0.15 c	2.39 ± 0.16 a	108.33 ± 1.53a	86.67 ± 2.89abc
8	8.61 ± 0.1	37.61 ± 0.39 c	29.00± 0.48 c	2.63 ± 0.04 d	1.23± 0.20bc	2.24 ± 0.03 a	100.33 ± 1.53a	77.50 ± 3.54 c
9	8.78 ± 0.07	48.84 ± 0.69 a	39.72 ± 0.83 a	3.05 ± 0.04 a	1.44 ± 0.04 bc	1.74 ± 0.05 b	85.00 ± 1.0 b	93.33 ± 2.89 ab

Data with same letter are not significantly different (P>0.05)
Key: Treatment 1 – Night/1% feeding rate, 2 – Night/3% feeding rate,, 3 – Night/5% feeding rate,, 4 – Day/Night 1% feeding rate,, 5 – Day/Night 3% feeding rate, 6 – Day/Night 5% feeding rate,, 7 – Day/1% feeding, 8 – Day/3% feeding rate,, 9 – Day/5% feeding rate,

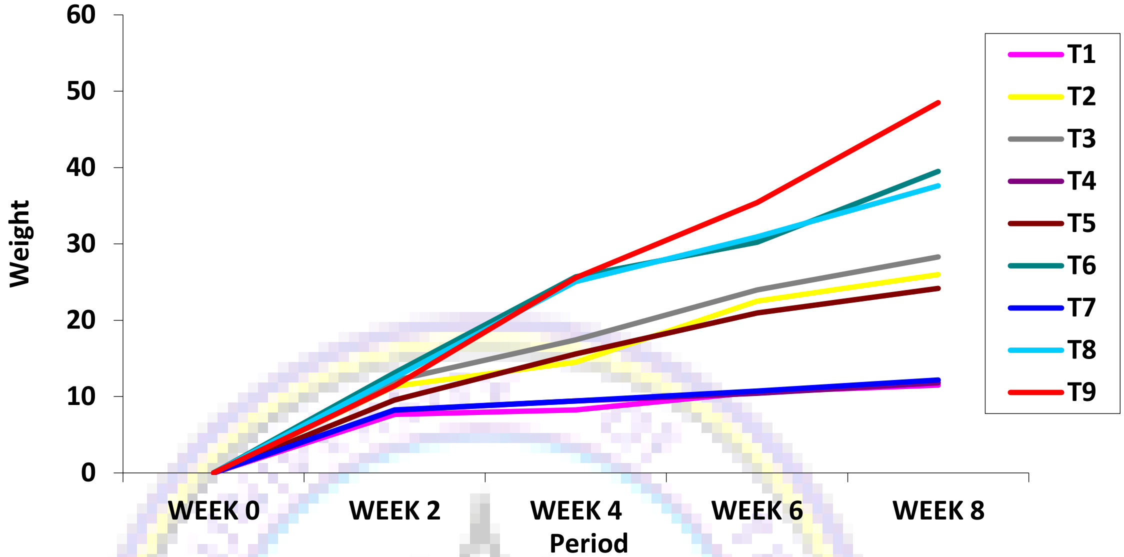

Figure 1: Growth response of photoperiod and feeding rate

The significant difference observed in this study shows that photoperiod and feeding rate (FR) has specific effect on *Clarias gariepinus* performance. This is in line with the report of Singh *et al.* (2003) who reported that percentage weight gain increase with the increase in feeding rates from 3 to 9% body weight per day. However, other variation might be due to differences in experimental conditions and methodology. Onye *et al*. (2015) reported that feed should be given at 5% of their body weight. The significant difference observed in MWG, SGR, FCR, PER, ANPU and Survival rates indicated positive influence of photoperiod on feeding rate of *Clarias gariepinus*. Treatment 9 (5% Feeding Rate/day feeding) with highest growth response followed by treatment 6 (5% Feeding Rate/day & night) indicated that 5% feeding rate has positive effect on *Clarias gariepinus*. Photoperiod and feeding rate impacted positively on the growth and nutrient utilization of *Clarias gariepinus.*

CONCLUSION

Photoperiod (12D:12L) interaction with 5% feeding rate will allow for high feed utilization and growth rate (3.05%/day).

References

Adebayo O. T. & Fagbenro O. A. (2004). Induced ovulation and spawning of pond raised African giant catfish, *Heterobranchus bidorsalis* by exogenous hormones. *Aquaculture*, 242: 229-236

Biswas, A. K., Endo, M. & Takeuchi, T. Effect of different photoperiod cycles on metabolic rate and energy loss of both fed and unfed young tilapia *Oreochromiis niloticus*: Part I. *Fisheries Science*. v.68, p.465-477. 2002.

Dwyer, K. S., Brown, J. A., Parrish, C. & Lall, S. A. (2002). Feeding frequency affects food consumption, feeding pattern and growth of juvenile yellowtail flounder (*Limanda ferruginea). Aquaculture*, 123(1-4): 279 - 292.

Kaushik, S. J. (2013). Feed management and on-farm feeding practices of temperate fish with special reference to salmonids. FAO Fisheries and *Aquaculture*. Technical Paper, 583: 519- 551.

Li, M. H., Robinson, E. H. and Hogue, C. 0.(2006). Catfish nutrition: Feeding food fish. Extension Service of Mississippi State University.

Onye, L. U., Kama, N., Michael, K. S. & Adewuyi, A. K., Growth Performance and Cost Benefit Analysis of *Clarias gariepinus* Fed with Different Commercial and Compounded Feeds. January, 2015. Vol. 3(1): 1-6

Priestly, S. M., Stevenson, E. S., & Alexander, L. G. (2006). The influence of feeding frequency on growth and body composition of the common goldfish (*Carrassius auratus*). *Journal Nutrition* 136: 1979S-1981S

Romanova, E. M., Romanov, V. V., Lyubomirova, V. N., Shadieva, L. A., & Shlenkina, T. M. (2020). Increase in nonspecific resistance of catfish (*Clarias gariepinus*) in industrial *aquaculture*. 810 Web of Conferences, 17, 00122. https:1/doi.org/10.1051/bioconf/2020 1700122.

Schnaittacher G, King W. & Berlinsky, D. L. (2005). The effects of feeding frequency on growth of juvenile Atlantic halibut, *Hippoglossus hippoglossus L Aquacult*. Res., 36:370-7.

Simensen, L. M., Jonassen, T. M., Imsland, A. K. and Stefansson, S. O. (2000). Photoperiod regulation of growth of juvenile Atlantic halibut (*Hippoglossus hippoglossus L.). Aquaculture*, 190: 119-128.

Singh, R. K., Vartak, V. R, , Balange, A. K. and Chavan, J. B. Effect of Feeding rate on the growth food conversion and protein efficiency of Silver Dollar *ninetynnis schreitmuller* 30, 2003, Journal of the Indian Fisheries Association Taraporevala Marine Biological Research, New Administrative Building 3rd floor, Bandra (East) Mumbai P.108

67 IMPACT OF COVID-19 INDUCED LOCKDOWN ON AQUACULTURE PRODUCTION IN MINNA, NIGER STATE, NIGERIA

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ABSTRACT

It is an established fact that the world has been ravage with corona virus pandemic, and expert have envisaged that the virus has come to stay. Thus, has affect virtually all facet of human endeavor especially the quality of food and meat we eat. Consequently, this study assessed the effects of the covid-19 induced lockdown on Aquaculture activities in Minna Niger State, Nigeria. Hence, a timeframe for this study is 12 months, (six months' pre- imposition of the lockdown order and six months' post-suspension of the lockdown order in Minna. The methods used in the data collection and data analyses techniques were both descriptive and inferential statistics. Whereas tables and charts used to present results. The t-test was used to determine the statistically significance difference in type of species cultured. The outcome of this study has shown that the outbreak of COVID-19 has impacted aquaculture value chain in both pre and post COVID period. The result showed that, there is no statistically significant difference in the species of fish sold and as well as the impact on its value chain. Thus, 92% of the respondent sold hybrid fish and 8% of them sold clarias before COVID while 12% of the respondent sold clarias catfish with 88% sold hybrid after covid. The study therefore, recommend that incentives should be put in place by Government and multinational agencies like world bank, Agricultural Development Bank and other Stakeholders in agricultural sector in order to cushion the effect of the Covid-19 pandemic.

Keywords: Covid-19, Aquaculture, Lockdown and Pandemic

INTRODUCTION

The COVID-19 disease is a global pandemic that has since its emergence affected all facets of human endeavours (Ghebreyesus, 2020), with the world's poorest being the most vulnerable UN-DESA, 2020 in UN-DESA, 2020). According to webmd.com (2020), there are other ways aside physical contact (that is, coming within six feet of an infected person without wearing a Personal Protective Equipment), of contracting the virus. These other ways are airborne transmission (because the virus can live in the air for up to 3 hours), surface transmission (touching an infected surface, as the virus can live up to 3 days on surfaces) and fecal-oral (being exposed to traces of an infected person's faces. As a result of these, the disease has a high transmission rate (Roy and Ghosh, 2020).

In order to halt the spread of the pandemic, some stringent measures were put in place by most countries of the world. One of which was the restrictive mass quarantine or the lockdown mechanism. The aim of the lockdown was to drastically reduce non-essential physical contact among individuals and possibly break the chain of transmission of the disease.

Coronavirus 2019 is a global health concern that has left most countries in a state of severe economic meltdown. Scientific research has been done on the virus and its impact on various sectors but that of the Nigerian aquaculture industry has been missing. Previous studies reviewed Adeleke *et al., (*2020) only looked at the perception of fish farmers on the influence of coronavirus and strategy to mitigate its impact. This paves for this research to aim at bridging the gap by looking at impact of corona virus on aquaculture and aquaculture value chain during pre and post covid 19 era in minna, Niger state. However, the impact of covid-19 induced lockdown has greatly affected the aquaculture activities and other value chain. However, as a result of increase in prices of goods and services for example, increase in prices of raw materials for fish meals which in turn affects the value chain production in aquaculture output. The restriction in movement during the lockdown period have impacted negatively on its value chain. Consequently, this study is set to assess the effects of the covid-19 induced lockdown on aquaculture production and its related activities in Minna metropolis Niger State, Nigeria.

MATERIALS AND METHODS

This chapter is based on the general approach/methodology used in the data collection exercise as well as the analyses techniques employed. In this research work, both primary and the secondary source of data collection was employed. The information/data from this sources was used to establish the background (introduction) to the study and it as well, formed the basis of the data analysis section. The information used in the introductory section was obtained from relevant dissertations, journals and conference proceedings, while the data used in the analysis section was sourced from the questionnaire administered to the fish sellers and fish producers in the study area. The data from the respondents in the study areas centered on the pre and post COVID-19 lockdown. Thus, observations to obtain first-hand information about the aquaculture production includes types of fishing activities, post-harvest and, the aquaculture value chain and as well as the impact of covid-19 induced lockdown on the aquaculture value chain in the study area. Data collected includes the types of fishing reared, inventory of facility use for fishing, source of water and types of feeds used for feeding etc. The timeframe for this study is 12 months, that is, six months before the imposition of the lockdown order on Minna and six months after the suspension of the lockdown order. For the purpose of clarity, the six months preceding the lockdown order ranged from 23rd September, 2019 to 23rd March, 2020, while the six months after the lifting of the lockdown covered from 20th April, 2020 to 20th October, 2020. Both the descriptive and inferential statistics were used in the data analysis exercise. The descriptive statistics was used in order to analyses the information obtained on the operations and/or activities of the fish sellers and fish producers in the study areas and this helped in answering questions such as "how many would-be/prospective developers applied for permits and how many permits were granted?" The inferential statistics on the other hand, answered questions like 'is there any statistically significant difference in the pre and post lockdown in fish sellers and fish producers?

The t-test analysis was employed in testing the hypotheses of the study. This is because the t-test analysis is statistically used to determine the existence of any significant difference between the means of two groups. These groups may however be related. The first hypothesis tested was to determine whether or not, there exists any statistically significant difference in the impact on types of fish sold in Minna in the six months preceding the imposition of the lockdown, and in the six months after the suspension of the total lockdown on Minna. Data on both the descriptive and inferential statistics were analyzed using the Microsoft Excel environment and the outcome were presented with the aid of the graphical tool (charts and tables). These tools in essence, helped in summarizing and describing the outcomes of the analysis.

RESULTS AND DISCUSSIONS

Variations in the Fish Culture Characteristics and Management Practices

Species of fish sold before COVID

The result of figure 1 revealed that 92% and 88% of the total respondents sold hybrid catfish before and after covids-19 while 12% and 8% of the respondent sold clarias catfish respectively. It is evident from the analysis that the respondents are mostly engaged in the selling of hybrid catfish in the study area.

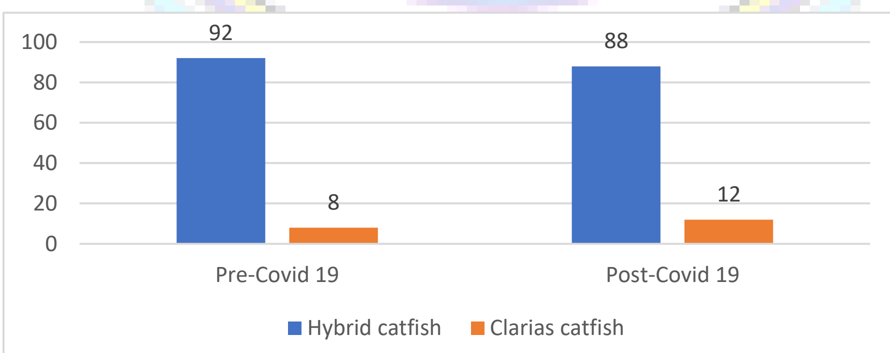

Figure 1: Types of Fish sold
Source field survey, 2022.

Record Keeping

The data obtained from the variables shows that 14% of the respondents have good record keeping, 40% have fair record keeping while 46% have poor record keeping. It is therefore deduced from the analysis that fish sellers have poor attitude towards record keeping in the study area.

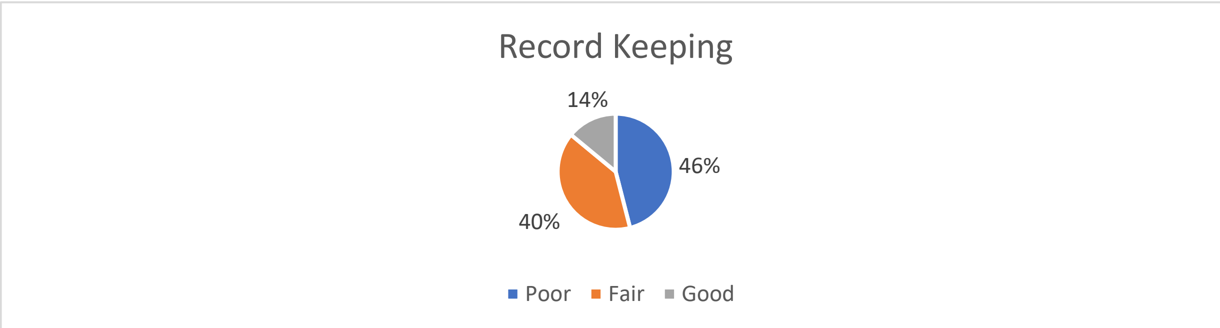

Figure 2: Periods of fish sales by Respondents

Sources: Field Survey ,2022

Impacts of Lockdown on Fish Sales and Distribution

Other non-fisheries related Business(es) involved

It is evident from the data reeled out from figurre3 that 44% of the respondents are into farming activities,2% of the respondents are into buying and selling goods. While 2% of the respondents are into carpentry work, trading, printing press, civil servant and business respectively. Thus, with 22% has no any other business they engaged in for livelihood. So it is deduced from the analysis that most of the fish sellers in the study area are also into farming activities to support or augment their fishing business as seen in the table below.

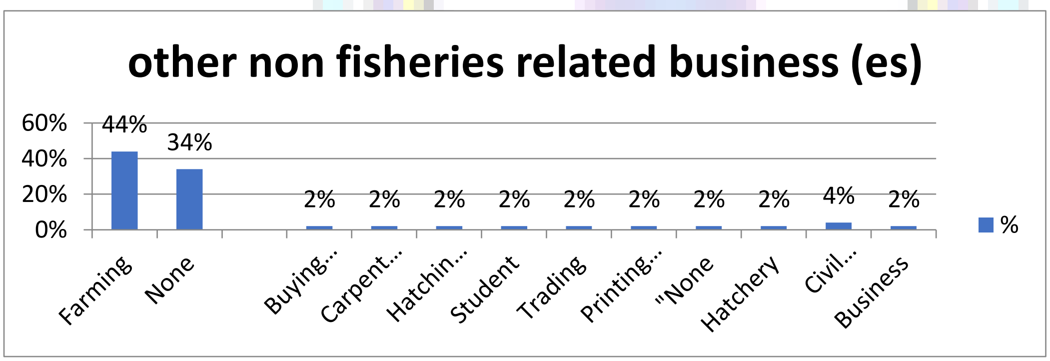

Figure 3: Other non-Fisheries related business

Sources: Field Survey ,2022

Types of aquaculture production before COVID 19

The data obtained from the figure below indicates that 64% of the respondents in the study area into grow out practices of fish production, 21% of the respondents are into sub-adults production while 7% of the respondents are into hatchery as well as all aspect of aquacultural production respectively. It is deduced from the analysis that quite a number of fish producers in the study area are mainly into grow out type of aquaculture production.

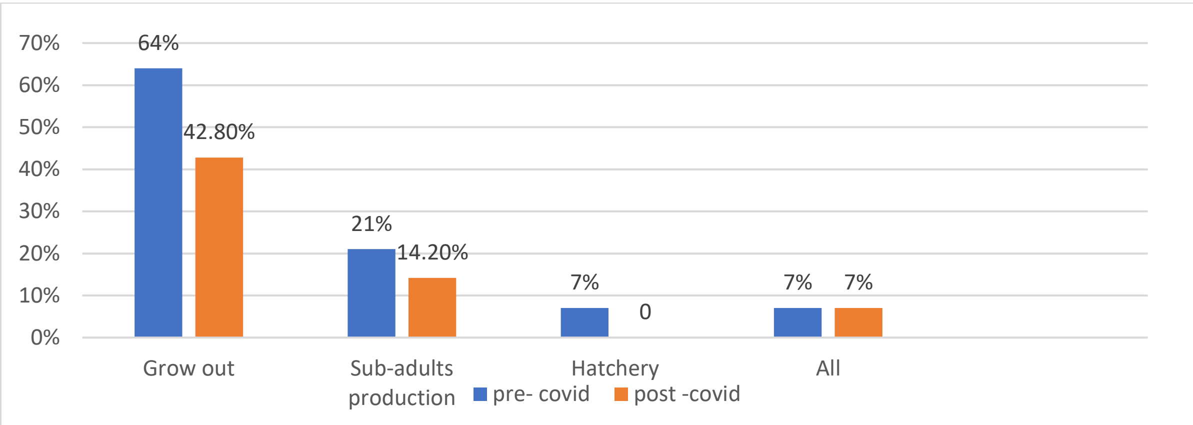

Figure 4: Types of aquaculture production

Sources: Field Survey ,2022

Hypothesis Testing

As earlier stated, the t-test analysis was employed to test the hypotheses set for this study. The outcome of the first hypothesis tested was to determine whether or not, there exists any statistically significant difference in the Species of fish sold in Minna in the six months preceding the imposition of the lockdown, and in the six months after the suspension of the total lockdown on Minna is presented in Fig.1. In order to attain this, the pre and post lockdown aquaculture value chain data in Figure 1 were respectively loaded. As shown in Table1, the recorded P-value is 0.486733. Hence, the p-value is greater than the significance level of 0.05. The implication of this is that the H_0 is accepted and the H_1 is rejected. This in other words means that there is no statistically significant difference in the species of fish sold in minna in the six months preceding the imposition of the lockdown, and in the six months after the suspension of the total lockdown on Minna in the pre and post COVID-19 induced lockdown period in Minna.

Table 1: t-Test: Paired Two Sample for Means (Species of fish sold)

	Variable 1	*Variable 2*
Mean	24.5	0.5
Variance	1104.5	0.4608
Observations	2	2
Pearson Correlation	1	
Hypothesized Mean Difference	0	
Df	1	
t Stat	1.042572	
P(T<=t) one-tail	0.243367	
t Critical one-tail	6.313752	
P(T<=t) two-tail	0.486733	
t Critical two-tail	12.7062	

CONCLUSION AND RECOMMENDATIONS

The outcome of this study has shown that the outbreak of COVID-19 has affected the Agriculture and Aquaculture industry in Minna. Hence, the outcome revealed that quantity of fish sold per day in the study area is more in the six months before the coronavirus induced lockdown were as reduces during the post lockdown period. This trend was similarly observed in the incidences of transportation of aquaculture products and also impacted negatively on other aquaculture value chain in the study area.

The study also revealed that there is no statistically significant difference in the species of fish sold in Minna in the six months preceding the imposition of the lockdown, and in the six months after the suspension of the total lockdown in Minna in the pre and post COVID-19 induced lockdown period in Minna. The outcome of the study similarly indicated that there is statistically significant difference in the other non-related fish business in Minna during the pre and post COVID-19 induced lockdown on Minna. While the last hypothesis outcome of this has in other words, shows post COVID-19 induced lockdown on Minna. The implication of this is that, it had seamless post lockdown aquaculture activities, as there was no any statistically significant difference in the types of aquaculture practice observed. Owing to some of the observed challenges identified by this study, the following recommendations significant have been put forward

1. The aquaculture producers should be encouraged in growing other species of fishes to boost production and have more dividends in return for profit.

2. There is need to embark on sustained advocacy on aqua culturist to grow exotics breeds that will withstand any adverse weather condition and also the need to keep proper farm records for sustainability in the business.
3. Finally, the study recommended that ~~I~~ncentives should be put in place by Government and multinational agencies like world Bank, Agricultural Development Bank and other Stakeholders in agricultural sector to cushion the effect of pandemic

Reference

Adeleke, B., Robertson-Andersson, D., Moodley, G., & Taylor, S. (2020). Aquaculture in Africa: A comparative review of Egypt, Nigeria, and Uganda vis-a-vis South Africa. *Reviews in Fisheries Science & Aquaculture*, *29*(2), 167-197.

Ghebreyesus, T. A. (2020). WHO Director-General's opening remarks at the media briefing on COVID-19, 13 April 2020. Available online at: https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19--13-april-2020 [accessed January 18, 2021]

Roy, S and Ghosh, P. (2020). Factors affecting COVID-19 infected and death rates inform lockdown-related policymaking. *PLOS ONE*. 15(10). ISSN e0241165. doi: 10.1371/journal.pone.0241165

United Nations Department of Economic and Social Affairs (UN-DESA, 2020). UN report finds COVID-19 is reversing decades of progress on poverty, healthcare and education. Available online at: https://www.un.org/development/desa/en/news/sustainable/ sustainable-development-goals-report-2020.html [accessed January 18, 2021]

Webmd.com (2020). How does coronavirus spread? Available online at: https://www.webmd.com/lung/coronavirus-transmission-overview#1 [accessed January 18, 2021]

68 EVALUATION OF ADAPTIVE PLASTICITY IN WILD *Sarotherodon Galilaeus AND Coptodon Zillii* IN CONCRETE POND

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Abstract

This experiment evaluates the adaptive plastic responses of wild Sarotherodon galilaeus and Coptodon zillii from Tagwai Dam Reservoir in concrete pond. Fifteen (15) adult samples of each species were collected via baited Malian traps and transferred to the experimental facility at Bosso Campus Fish Farm, Federal, University of Technology, Minna. The samples were held in hapas-in-concrete-pond for 243 days (8-months). somatic and breeding data such as: mean survival rates: 0.27 (27%) and 0.33 (33%), mean final body weights gain: 76.62 ± 26.48 and 43.92 ± 17.08, breeding (fry produced): 201 and 379, progressive breeding trendline (polynomial) equation: $y=15.56x^2-160.58x+387.86$, $R^2=0.7861$ and $y=10.143x^2-101.21x+230.71$, $R^2=0.7534$ were calculated for S. galilaeus and C. zillii, respectively. Survivorship was low (<50 %) for both species in contrast to growth performance (weight gain) by which S. galilaeus was significantly ($p<0.05$) better. Statistical significances were determined by means of Independent-Samples t-test analysis in IBM SPSS 21. The length-weight regression analysis showed $b>3.0$ (positive allometric growth) for both species with high regression coefficient (R^2 > 90 %). The condition factor (K) for S. galilaeus and C. zillii were 3.07g/cm3 and 3.45g/cm3, respectively, are good indications of wellbeing of the species in captivity. The survival, growth, and breeding in the captive fishes are precursors to the aquaculture potentials of local strains of S. galilaeus and C. zillii. A comprehensive study of the adaptation processes of the species are hereby recommended.

Keywords: Survivorship, breeding trendline, hapas-in-concrete-pond, polynomial equation, condition factor, Growth Pattern, Tagwai Dam Reservoir.

Introduction

Domestication is described to be a selection operation for adaptation to human agro-ecological niches on one hand, and to human orientations at certain point. Expectedly, the wild parents of domesticated species must have possessed the potency to live in human ecologies, and expressed traits favourable for human uses (Larson *et at*., 2014).

Some ten thousand years ago, Homo sapiens, approximately four million of them, were all hunter-gatherers. However, to avoid roaming, in search for naturally occurring food, humans resolved to manipulate the natural world and surround themselves with their needs closer at hand (Scott, 2011).

Aquaculture is often seen as the only key for providing more fish products, given that harvesting wild stocks have reached the upper limit. In aquaculture, only a few species, are considered truly domesticated, like cattle or sheep. Telethon (2014) suggested two scenarios for the future of aquaculture: focusing on few truly domesticated species, like the path taken by agriculture, but avoiding its negative impacts, or aquaculture proceeds with species diversification primarily focusing on domesticating wild strains/species.

Tilapia are fishes with outstanding aquaculture attributes. Their commercial place value has been purportedly occupied by *Clarias spp.* in Nigeria. Their advantages as warm water species include low cost of production; in terms of fry and feeds, high quality flesh, resistance against unfavourable conditions, flexibility of breeding, fast growth rate, ability to efficiently convert organic and domestic waste into high quality protein and good taste (Watanabe*et al al*., 2002; Fuentes-Silva *et al*., 2013).

This research was undertaken to study the adaptability of wild *Sarotherodon galilaeus* and *Coptodon zillii*, which is known for its adaptability to captivity.

Materials and Methods

Recruitment Site: Fish samples for the research were recruited from Tagwai dam in Tagwai village, Bosso Local Government Area, Niger State.

Experimental Site: The experiment was conducted at the Department of water Resources, Aquaculture and Fisheries Technology, Teaching and Research Farm, Bosso Campus, Federal University of Technology, Minna, Niger State.

Experimental Facilities: The experiment was conducted in Hapas-in-concrete-pond system comprising a concrete pond and six (6) net hapas made of 0.5″ mesh size net knitted on 10x5x1.5 m squared cylindrical plastic pipes.

Pond preparation for introduction of experimental fishes: In line with Adigun (2005), the pond was drained and allowed to dry before letting in water two weeks ahead of introduction of the experimental fishes. Fertilization was done in compliance with the National Agricultural Extension Liaison Services (2003) and Adigun (2005) to stimulate the production of natural fish food, using organic manure (poultry droppings) at 0.1kg/m^2. Thereafter, the same rate was applied for weekly fertilization throughout the 8-month study.

Recruitment of the Specimens: Thirty adults (fifteen adult samples of each species) were collected from Tagwai Dam by means of Malian traps. The samples were kept in two cages (assigning each species to a cage) at the dam and transferred to the experimental pond between 6 and 8 pm.

Water quality Parameters: Water quality of Tagwai Dam and the experimental pond were determined as recommended by APHA (2014).

Transportation of Experimental fishes: The samples were transported in aerated polythene bags to the experimental pond. Water in the transportation bags was prepared in line Emmanuel *et al.* (2013).

Stocking of Experimental Fishes: The stocking procedures took place between 5h00 pm and 7h00 pm. Samples were randomly distributed into six hapas–in–concrete-pond in three replicates of five (5) specimens each by species. The fishes were released in to the hapas by allowing the water in the vessel to gradually mix with water from the receiving environment (pond) to equilibrate temperatures and water chemistry to avoid sudden fluctuations (Michael *et al.*, 2012).

Feeding of Experimental Fishes: Apart from the natural food materials available in the pond, supplemental feed (MULTI FEED) at 5% body weight twice daily (morning and afternoon).

Cumulative Survival and survival Rate: Records of cumulative survival from each replicate were taken with notes on the number and cause of mortality as well as number of survivors. Survival rate expressed as follows:

Survival rate: $lx = \frac{nxi}{nx2}$ adapted from Weistein (2015)

Where lx = proportion surviving over time (survival rate)

nxi = Number alive initially (at previous time)

nx2 = Number alive at the given time

Cumulative survival was computed as: Survival = $N_0 - N_1$

Where N_0 = Number alive initially (at time t_0)

N_1 = Number alive at time t

Morphometrics of the experimental samples: Morphometrics assessment was conducted fortnightly when all samples were removed and returned after taking their body weight, total length, standard length. The body weight was read to the nearest 0.01g. The standard and total length of individual samples were taken with a meter rule to the nearest 0.1cm.

Measurement of growth performance: The growth performance was measured using indies which include growth rate, growth pattern and condition factor.

Measurement of growth rate: The growth was calculated as:

$$GR = \frac{WF - W1}{W1} \times 100$$

Where, GR = growth rate, WF = final weight (cm) and W1 = initial weight (cm)

Growth Pattern and Condition Factor:

W = aLb

Where, W =weight (g), L= standard length (cm).

The length-weight relationship (LWR) was expressed by the equation:

Log weight = Log a + b Log length

Where 'a' and 'b' are regression constants (Mensah, *et al*., 2014).

The condition factor was calculated using the Formula:

Kn = [100 W] / L3 (adopted from, Mensah, *et al*., 2014).

Where Kn = condition factor, L = standard length (cm) and W =weight (g).

Data Analysis: significant differences between the treatments in terms of weight gain, increase in total and standard lengths, body width and depth were determined via Independent Sample t-test using SPSS IBM Version: 21. Length-weight relationship was determined using linear regression Microsoft 365 Excel.

Results

Table 1: Mean values of the t-test analysis of quality variables of the source water in Tagwai Dam and the Experimental Pond for captive *S. galilaeus C. zillii*

Variable	Tagwai Dam Reservoir	Experimental pond
Dissolved oxygen (mg L-1)	8.04 ± 0.11^{a}	7.65 ± 0.39^{a}
pH	6.79 ± 0.10^{a}	7.99 ± 0.04^{b}
Conductivity (µS/cm)	58.50 ± 8.24^{a}	163.33 ± 4.36^{b}
Transparency (cm)	36.00 ± 2.00^{a}	28.00 ± 0.46^{b}
Hardness (mg L-1)	25.00 ± 0.21^{a}	38.00 ± 0.05^{b}
CO_2 (mg L-1)	0.21 ± 0.06^{a}	0.23 ± 0.07^{a}
Temperature (˚c)	26.00 ± 1.26^{a}	26.67 ± 0.82^{a}

Table 1: shows the mean values of quality variables of water samples taken from Tagwai Dam and the experimental pond during recruitment, pre and after stocking. Statistical differences between transparency, hardness, pH, and conductivity of water samples from the two sights were significant ($p < 0.05$).

Table 2: Analysis of the weights, and standard lengths of captive *S. galilaeus* and *C. zillii* held (243 days) in concrete pond culture environment

Species	Survival rate	Mortality	Mean final Std. Length (cm)	Mean final Weight (g)	Mean weight gain
S. galilaeus	0.27±4.21[a]	11	20.99±0.34[a]	382.5±2.71[a]	76.62±26.48[a]
C. zillii	0.33±10.17[a]	10	16.93±0.56[a]	169.425±5.53[b]	43.92±17.08[b]

Survivorship of *S. galilaeus* and *C. zillii*

Table 2 contains the survival rate of the species in captivity. At age 1 (2-weeks after stocking). Survivorship suddenly dropped at the rate of 0.27 (27 %) and 0.33 (33) respectively. No further mortality was recorded after age 1 to the termination of the study. That was an indication of adjustment to the pond environment.

Mean weight gain

In figure 1: The mean weight gain, increase in total and standard lengths of the samples showed continuous weight increase to the last month of captivity. C. zillii was relatively steady in gaining weight early but proceeded at decreasing rate at later period of captivity. Overall, S. galilaeus was significantly ($p < 0.05$) superior in its final somatic indices which include mean final mean weight and weight gain.

Table 3: Growth function and Condition factor (Kn) of captive *S. galilaeus* and *C. zillii*) in concrete pond culture environment

Sample	a	b	SE of b	R^2	K (±SD)
S. galilaeus	-10.421	5.5044	2.49	0.9302	3.07±0.28[a]
C. zillii	-11.229	6.006	2.45	0.09767	3.45±0.22[b]

Table 3: Shows ‘a’, ‘b’ and ‘R^2’ derivatives of the logarithmic length-weight interaction analysis expressed as polynomial growth trendlines of the experimental *S. galilaeus* and *C. zillii*. The expressions entail positive allometric coefficient ‘b’ for both species with emphatically strong correlation coefficients: R^2 0.93 and R^2 0.97 respectively. The R^2 values suggest sublime fitness of the regression model in accounting for the interactive effect of the length-weight variables of the samples assessed.

Furthermore, the K value (3.07 and 3.45), imply positive allometric growth and a state of healthy living condition for both *S. galilaeus* and *C. zillii* in the pond.

Reproductive Performance of the experimental fishes

Figure 1 is a graphical representation of the breeding accounts (numbers of fry produced) of *S. galilaeus* and *C. zillii* over the period of captivity. Both species expressed similar breeding pattern (February - May) in captivity as shown by the regression curve. *Tilapia zillii* had higher fecundity all through their breeding interval. In both species, peak fecundity was recorded f at the onset of captivity. Subsequently, fecundity declined along the months until complete cessation of breeding after the fourth month.

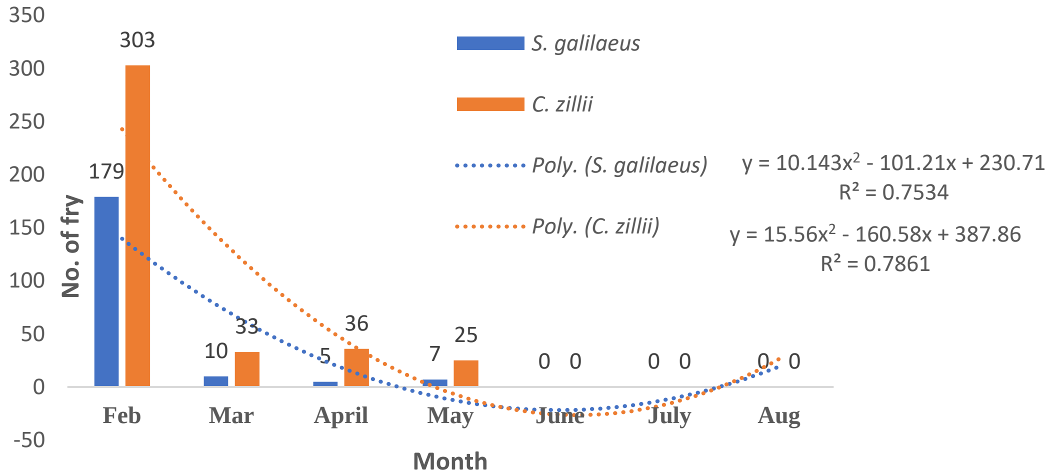

Figure 1: Simple curves describing the progressive polynomial breeding trendline of captive *S. galilaeus* and *C. zillii* through 8-month captive period in hapas-in-concrete pond environment.

Discussion

Water quality parameters of Tagwai Dam and the experimental pond

The major or perhaps, the most critical quality parameters of water (DO, pH, CO_2, and temperature) were within desirable limits for both the river and pond environments (Bhatnagar and Devi, 2013; Costa-Pierce, 2003; FishBase, 2008) despite significant variations ($p < 0.05$).

Reproductive performance of the experimental fishes

The lower fecundity of *S. galilaeus* in captivity may be linked to its mouth brooding strategy which proceeds with low fecundity as observed by Achionye-Nzeh (2011).

Survivorship of experimental fishes

Both species were severely affected with barely (27%) and (33%) survivorship of *S. galilaeus and C. zillii.* The is instructive of their stress sensitivity as observed by Liao and Huang (2000) that, certain stress-sensitive species are affected by nutritional-immunity-endocrine problems resulting from stress. This may be linked to jumpiness upon introduction to the captivity (Zeder, 2012).

Mean Weight gain and growth rate

The significant variation ($p<0.05$) observed between the species mean weight gain may have resulted from factors such as species, genetic variation, and response to captivity (Mensah, *et al*., 2014).

Length–weight relationship

Continuous growth, according to Saha, *et al*. (2009), indicates abundance of food supply and other conditions of wellbeing, whereas slow growth potentially indicate non-availability of food. Saha, *et al*. (2009) postulated that the values of 'a' and 'b' differs between species depending on sex, stage of maturity and food habits. The exponent values for *S. galilaeus* and *C. zillii* were positively allometric. The higher values of Kn in this study is useful as a tool for measuring the relative robustness or wellbeing of spaces in pond environment (Bake, *et al*., 2014).

Conclusion

Most cases of mortality resulted from stress related incidences, hence, both *S. galilaeus* and *C. zillii* are highly susceptible to (handling) handling stress.

The use of hapas-in- concrete pond does not encourage free movement of the wild species in captivity with consequent interference threat to biological activities such as survival, feeding and even breeding of the species in captivity.

With assurance of survival, growth, and breeding, it is reasonable to conclude that the two species could be truly domesticated for the enhancement of local aquaculture production, through species diversification, crossbreeding and other research endeavours of aquacultural benefits.

Recommendations

Introduction and domestication of local *S. galilaeus* should be encouraged for diversification of local aquaculture production since assurance of the survival and growth of the species in captivity has been verified.

A holistic study of local strains *S. galilaeus* should be conducted to provide research template for possible domestication of the cichlid.

References

Adigun, B. A. (2005). Water quality management in aquaculture and freshwater Zooplankton production for use in fish hatcheries. 1st Edition, Alabi Printing Production Ltd. Ilorin, 26pp.

Achionye-Nzeh, C. G. (2011). Reproductive strategies of the Cichlids in a small reservoir in Ilorin, Nigeria. International Journal Biological and Chemical Sciences. 5(4), 1688-1693

APHA, A.W.W.A. (2014). Standard Methods for the Examination of Water and Wastewater. 142nd Ed. American Public Health Association, New Orleans, Louisiana, USA.

Bake, G. G., Kpotun, A., Egwin, E. C. and Sadiku, S.O.E (2014). Growth pattern, Condition Factor, and proximate composition of *Synodontis membernaceus* from river Kaduna Flood plains, Nigeria. International Journal of Applied Biological Research. 6(1), 31-44.

Bhatnagar, A. and Devi, P. (2013). Water quality guidelines for the management of pond fish culture. *International Journal of Environmental Sciences*. 3(6), 1980-2009.

Costa-Pierce, B.A. (2003) Use of Ecosystems Science in Ecological Aquaculture. Bull. Aquaculture Association. Canada 103-2.

FishBase (2008). Ecology of *Tilapia zillii*. National Biological Information Infrastructure (NBII) & IUCN. ManaakiWhenua-Landcare Research and the University of Auckland.

Fuentes-Silva, C., Soto-Zarazúa, G. M., Torres-Pacheco, I., & Flores-Rangel, A. (2013). Male tilapia production techniques: A mini-review. African journal of Biotechnology, 12(36).

Larson, G., Piperno, D. R., Allaby, R. G., Purugganan, M. D., Andersson, L., Arroyo-Kalin, M. and Fuller, D. Q. (2014). Current perspectives and the future of domestication studies. In: Inder, V. (ed), Special Feature: Introduction, pp.6139–6146. High Wire Press, Washington.

Liao, I.C. & Huang, Y.S., (2000). Methodological approach used for the domestication of potential candidates for Aquaculture. Recent advances in Mediterranean Aquaculture Finfish Species Diversification. Zaragoza, CHEAM: pp 97-107.

Mensah, E. T., Attipoe, F. K. Y., Atsakpo, K. (2014). Comparative growth study of *Oreochromis niloticus* and *Sarotherodon galilaeus* under two different culture regimes (Hapa-In-Pond and cage systems**).** *International Journal of Fisheries and Aquatic Studies*. 1(5), 53-59.

Michael, H., Adam, B., Andrew, N., John, K. and Keith, C. (2012). A review of domestication effects on stocked fishes, strategies to improve post stocking survival of fishes and their potential application to threatened fish species recovery programs in the Murray–Darling Basin. 1st Edition, MDBA Publication. Australia, 48pp

National Agricultural Extension Liaison Services (2003). Fishpond fertilization techniques. Extension Bulletin No. 153, Fisheries Series No. 8. Ahmadu Bello University, Zaria.

Saha, S. N. Vijayan and, P. and Rajagopal, S. (2009) Length-weight Relationship and Relative condition factor in *Thenus orientalis* (Lund, 1793) along east coast of India. *Current Research Journal of Biological Sciences.* 1(2), 11-14.

Scott, J. (2011). Tanner Lectures on Four Domestications: Fire, Plants, Animals, and Us. Retrieved from http://mahindrahumanities.fas.harvard.edu/content/james.

Telethon, F. (2014). Levels of domestication in fish: implications for the sustainable future of aquaculture. *Fish and Fisheries Journal*. 15 (2), 181–195.

Watanabe, W. O., Losordo, T. M., Fitzsimmons, K., & Hanley, F. (2002). Tilapia production systems in the Americas: technological advances, trends, and challenges. Reviews in fisheries science, 10(3-4), 465-498.

Weistein, E. W. (2015). “Life expectancy” from Mathworld, a Wolfran web resource retrieved from: http://mathworld.wolfran.com/lifeexpectancy.html

Zeder, M. A. (2012) Pathways to Animal Domestication. In: Bettinger, *et al*. (eds), Biodiversity in Agriculture, pp. 227-229. Cambridge University Press, Cambridge.

69 EFFECT OF PROCESSED SELECTED MEDICINAL PLANTS DIETS ON HAEMATOLOGICAL PARAMETERS OF *CLARIAS GARIEPINUS* (BURCHELL, 1822)

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ABSTRACT

An experiment was conducted to test the effect of some processed medicinal plants on haematological parameters of Clarias gariepinus. The plants were processed with aqueous ethanol and hexane solvent. Thirteen diets with 3% and 5% inclusion level of the processed plants were formulated and diet with zero medicinal plant serving as a control. Water quality parameters measured were within the recommended standard range. The results of the tested diets were within the haematological recommended range. There were significant difference (P>0.05) among the tested diets. There were increase in RBC count 3% EAQ ($4.00\pm0.20\times10^{6}$/l), ($4.10\pm0.10\times10^{6}$/l) and 5% MHX ($4.00\pm0.10\times10^{6}$/l) based diets. The RBC count of all the tested diets were observed to be significantly higher than control diet ($2.40\pm0.20\times10^{6}$/l). There were varying increase in White Blood Cell (WBC) Count among the experimental based diets while 3% EET ($10.30\pm0.30\times10^{9/}$l), 3% MAQ ($10.60\pm0.20\times10^{9/}$l) and 5% EET ($10.30\pm0.10\times10^{9/}$l) were least significant (P>0.05) among the tested processed Medicinal plants diets. There were significant difference (P>0.05) among haemoglobin (Hb), MCV and MCH while no significant difference were observed in PCV, MCHC counts. The tested shows haematological significant contribution to fish survival due to high immunity and resistance against anaemic condition. 3% and 5% inclusion levels of medicinal processed diet both have similar haematological positive impact on Clarias gariepinus but 3% is recommended for use due to the growth performance of the fish measured during the study.

Keywords: Haematology; Aqueous; Ethanol; Hexane; and *Clarias gariepinus*

INTRODUCTION

Aquaculture production in Africa has been on a steady increase, growing more rapidly in Sub-Saharan African countries than the rest of Africa countries on the continent (FAO, 2012). According to Halwart (2020), the contribution of Africa to the global production of aquaculture in 2018 was estimated at 21,296 metric tons representing an insignificant 2.67% and was mainly dominated by freshwater finfish production. Nigeria population as at July, 2021was estimated to be 211,400,708 and the highest demand for fish in Africa and has also been identified to have been the largest producer of African catfish (Adeleke *et al*., 2021).

However, during the past few years, aquaculture has encountered repeated problems of diseases emanated from feed due to poor availability of suitable constituent, lack of adequate knowledge on feed preparation, poor formulation and processing of ingredients and lack of knowledge and understanding of dietary requirement of targeted fish species (Fagbenro *et al*., 2013). The best way to curtail the challenges of fish losses in this regard is to improve their resistance to infections in addition to improving husbandry with good health management (Anjusha *et al*., 2019). Disease is a considerable constraint in aquaculture expansion, production and development. Recent research has been demonstrating the positive effect of medicinal plants incorporation with aqua-feed formulation in fish culture (Anjusha *et al*., 2019).

Haematology investigation serves mainly for diagnostic purpose. It can be used to appraise suitability of feeds and examine the stress situation of fish (Fagbenro *et al*., 2013). It is one of the diagnostic tools for identifying diseases. Normal variation from intrinsic or extrinsic factors or diseases affecting blood cells and counts may be evaluated by clinical haematology (Grant, 2015). Most of the fish have nucleated erythrocytes which play an important role in oxygen transport, which depends on the amount of haemoglobin concentration within the cell and the gas exchange mechanism (Fauci, 1993; Anjusha *et al*., 2019).

MATERIALS AND METHODS

Feeding trial was conducted at the indoor hatchery of the farm complex of the Department of Fisheries and Aquaculture, Bayero University Kano, Nigeria. Latitude 11.978422°N and longitude 8.424395°E. *Eucalyptus globulus* and *Moringa oleifera* leaf meals were subjected to Aqueous, Ethanol and Hexane processing methods. Each was measured 250g into 1000 ml labelled bottle using Ohaus sensitive weighing balance (PA313). The meals were soaked with 500 ml of the aforementioned solvents (Suleiman *et al*., 2018) in a tightly covered bottles s and agitated at interval of 8 hours for a period of 72 hours and filtered using muslin (Ezearigo *et al*., 2014). The filtrate was evaporated to dryness under pressure at 45°C using rotary evaporator (RE300). The extracts were labelled as Eucalyptus Aqueous (EAQ), Eucalyptus Ethanol (EET), Eucalyptus Hexane (EHX), Moringa Aqueous (MAQ), Moringa Ethanol (MET) and Moringa Hexane (MHX) respectively. The extracts were preserved at -4°C until further usage (Chakraborty *et al*., 2018).

Diet Formulation

Thirteen diets (40% Crude Protein) were formulated for the experiment. It was done based on the determination of proximate compositions of the ingredients using AOAC (2010) with incorporation of 3% and 5% inclusion levels of processed plants (Table 1a and 1b). The extract were dissolved in 350 ml of warm water which was used to form a uniform dough-like paste. The feeds were pelleted to 2 mm size using improvised manual pelletiser and dried at 26°C for 72 hours (Ochang *et al*., 2015; Jiomh *et al*., 2022).

Table 1a: Feed Formulation Showing Inclusion Levels of Processed Medicinal Plants (Eucalyptus and Moringa) Diets

Ingredients	D1 ZMD	D2 (3%EAQ)	D3 (3%EET)	D4 (3%EHX)	`D5 (3%MAQ)	D6 (3%MET)	D7 (3%MHX)
FM (61.45%)	25.71	24.90	24.90	24.90	24.90	24.90	24.90
SBM (40.05%)	51.42	49.80	49.80	49.80	49.80	49.80	49.80
MM (9%)	17.87	17.30	17.30	17.30	17.30	17.30	17.30
Moringa	0.00	0.00	0.00	0.00	3.00	3.00	3.00
Eucalyptus	0.00	3.00	3.00	3.00	0.00	0.00	0.00
Oil	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Lysine	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Methionine	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Bone Meal	0.50	0.50	0.50	0.50	0.50	0.50	0.50
VMP	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Total	100	100.00	100.00	100.00	100.00	100.00	100.00
Proximate Compositions (%) of the Experimental Diets formulated at 3% and 5% Inclusion Levels of Medicinal Plants							
Ash (%)	12.63	12.66	12.52	12.38	12.65	9.45	11.92
Crude Fibre (%)	4.07	4.17	4.4.00	4.63	2.28	5.83	6.05
Fat (%)	16.52	11.76	11.97	12.18	8.95	10.84	10.54
Crude Protei (%)	43.22	38.05	40.01	39.72	42.34	42.00	41.50
Moisture (%)	7.05	5.45	5.31	5.63	5.93	5.03	6.10
Carbohydrate (%)	16.51	27.91	25.79	25.46	24.85	26.85	23.89
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00

FM = Fishmeal, SBM = Soybean Meal, MM = Maize Meal, VMP = Vitamin and Mineral Premix, ZMD = Zero Medicinal Diet, EAQ = Eucalyptus Aqueous, EET = Eucalyptus Ethanol, EHX = Eucalyptus Hexane, MAQ = Moringa Aqueous, MET =Moringa Ethanol and MHX = Moringa Hexane

Table 1b: Feed Formulation Showing Inclusion Levels of Processed Medicinal Plants (Eucalyptus and Moringa) Diets

Ingredients	D8 (5%EAQ)	D9 (EET5%)	D10 (5%EHX)	D11 (5%MAQ)	D12 (5%MET)	D13 (5%MHX)
FM	24.36	24.36	24.36	24.36	24.36	24.36
SBM	48.71	48.71	48.71	48.71	48.71	48.71
MM	16.93	16.93	16.93	16.93	16.93	16.93
Moringa	0.00	0.00	0.00	5.00	5.00	5.00
Eucalyptus	5.00	5.00	5.00	0.00	0.00	0.00
Oil	3.00	3.00	3.00	3.00	3.00	3.00
Lysine	0.50	0.50	0.50	0.50	0.50	0.50
Methionine	0.50	0.50	0.50	0.50	0.50	0.50
Bone Meal	0.50	0.50	0.50	0.50	0.50	0.50
VMP	0.50	0.50	0.50	0.50	0.50	0.50
Total	100	100	100	100	100	100
Proximate Compositions (%) of the Experimental Diets formulated at 3% and 5% Inclusion Levels of Medicinal Plants						
Ash (%)	13.38	13.88	12.54	12.75	10.31	13.92
Crude Fibre (%)	6.09	6.09	4.64	5.35	4.88	4.45
Fat (%)	12.22	12.22	12.91	14.24	12.65	13.09
Crude Protei (%)	41.60	41.80	38.36	39.2	38.82	40.36
Moisture (%)	4.76	4.79	5.93	5.40	5.48	6.09
Carbohydrate (%)	21.95	21.22	25.62	23.06	27.86	22.09
Total	100	100	100	100	100	100

Experimental Design

Clarias gariepinus fingerlings (9.66 ± 0.15 g) were acclimatize to experimental condition for two weeks before being distributed to various experimental units. Fish were starved 24 hours prior to the commencement of feeding trials in order to increase their appetite and eliminate variation in weight due to residual feed content that may be left in their gut (Ochang *et al*., 2015). Fish are weighed equally and distributed into various experimental units using an electronic digital sensitive weighing balance (MP300) at a stocking density of 20 fish per experimental unit. Water quality parameters were monitored weekly, they were fed 5% of their body weight daily with equal meals being fed between 10 am and 16 pm.

Blood Sample Collection and Haematological Determination

Haematological parameters was conducted before and after the experiment suing (Kelly, 1979) procedures. Fish were carefully caught randomly, one at a time with least disturbance. Each fish was held at the head region, carefully lifted with one hand to a comfortable handling position while the other hand was used to hold 2 ml syringe and needle which was inserted into the fish at a perpendicular angle of 45°

to the anal fin to the vertebral column and desirable blood sample was collected and transferred into anticoagulant Ethylene Di Amine Tetra Acetic Acid (EDTA) labelled tubes (Argungu *et al*., 2017). The tubes containing the samples were gently mixed with the anticoagulant after covering them and kept in a sample box containing ice prior to haematology analysis.

Statistical Analysis

The experimental data were subjected one way Analysis of Variance (ANOVA) using Statistical Package for Social Scientists (SPSS) version 16.0 to test the effect among the treatment means at 0.05 significant difference. Multiple comparisons among the treatments were achieved using "R" statistical packages.

Results

Table 2a and 2b shows the haematological parameters of the *Clarias gariepinus* fingerlings that were fed 3% and 5% inclusion levels of processed medicinal plants diets. Definite variations were dictated among the various treatments. High levels of Red Blood Cell (RBC) count were observed in 3% EAQ ($4.00 \pm 0.20 \times 10^6$/l), 3% MAQ ($4.10 \pm 0.10 \times 10^6$/l) and 5% MHX ($4.00 \pm 0.10 \times 10^6$/l) as they were not significantly different ($P>0.05$) from each other. The RBC count of all the tested diets were observed to be significantly higher than the control diet ZMD ($2.40 \pm 0.20 \times 10^6$/l). There were varying increase in White Blood Cell (WBC) Count among the experimental based diets while 3% EET ($10.30 \pm 0.30 \times 10^{9/}$l), 3% MAQ ($10.60 \pm 0.20 \times 10^{9/}$l) and 5% EET ($10.30 \pm 0.10 \times 10^{9/}$l) were least significant ($P>0.05$) among the tested processed Medicinal plants diets. Haemoglobin (Hb) in all the tested diets were observed to be significantly ($P>0.05$) higher than the control diet ($6.60 \pm 0.20 \times 10$g/dl). The Mean Cell Volume (MCV) and Mean Cell Haemoglobin (MCH) counts in this study appeared to be significantly ($P>0.05$) different among all the tested diets. However, the Mean Cell Haemoglobin Concentration (MCHC) count for all the experimental diets were not significantly ($P>0.05$) different from each other. The water quality parameters measured during the experiments are Temperature (27-30°C), pH (6.6 – 8.4) and Dissolved Oxygen (3-5 mg/l).

Table 2a: Haematological Parameters of *Clarias gariepinus* fed Processed Medicinal Plants Diets

Parameters	D1 ZMD	D2 (3% EAQ)	D3 (3%EET)	D4 (3%HEX)	D5 (3%MAQ)	D6 (3%MET)	D7 (3%MHX)
RBC×10^6/l	$2.40±0.20^{ef}$	$4.00±0.20^{ab}$	$3.27±0.15^{cd}$	$2.10±0.10^{f}$	$4.10±0.10^{a}$	$3.60±0.20^{abc}$	$2.80±0.00^{de}$
WBC×10^9/l	$14.60±0.10^{de}$	$16.80±0.20^{cd}$	$10.30±0.30^{f}$	$18.07±0.15^{bc}$	$10.60±0.20^{f}$	$13.73±0.31^{e}$	$15.93±0.15^{cde}$
PCV (%)	$20.00±1.00^{j}$	$34.00±0.00^{a}$	$29.00±1.00^{bcd}$	$22.00±1.00^{ij}$	$30.00±1.00^{bc}$	$33.00±1.00^{ab}$	$25.00±1.00^{gh}$
Hb (g/dl)	$6.60±0.20^{h}$	$11.30±0.10^{ab}$	9.60±0.20d^{ef}	$7.30±0.20^{h}$	$10.00±0.10^{de}$	$11.00±0.10^{bc}$	$8.30±0.20^{g}$
MCV(fl)	$83.97±11.21^{bc}$	$85.17±4.25^{bc}$	$89.03±7.27^{b}$	$104.77±0.25^{a}$	$73.23±4.25^{c}$	$91.83±4.57^{b}$	$89.30±3.60^{b}$
MCH (pg)	$27.67±3.15^{bcd}$	$28.30±1.20^{bcd}$	$29.43±2.02^{bc}$	$34.8667±2.60^{a}$	$24.43±0.85^{d}$	$30.63±1.63^{ab}$	$29.63±0.75^{bc}$
MCHC (%)	$33.03±0.65^{a}$	$33.20±0.30^{a}$	$33.13±0.45^{a}$	$33.27±2.40^{a}$	$33.33±0.75^{a}$	$33.33±0.75^{a}$	$33.23±0.55^{a}$

Average values on the same row with similar superscripts are not significantly different (P>0.05) from each other. RBC = Red Blood Cell, WBC = White Blood Cell, PCV = Pack Cell Volume, Hb = Haemoglobin,

Table 2b: Haematological Parameters of *Clarias gariepinus* fed Processed Medicinal Plants Diets

Parameters	D1 ZMD	D8 (5%EAQ)	D9 (5%EET)	D10 (5%EHX)	D11 (5%MAQ)	D12 (5%MET)	D13 (5%MHX)
RBC×10^6/l	$2.40±0.20^{ef}$	$3.33±0.49^{cd}$	$2.80±0.10^{de}$	$3.10±0.10^{cd}$	$3.10±0.10^{cd}$	$3.47±1.10^{bc}$	$4.00±0.10^{ab}$
WBC×10^9/l	$14.60±0.10^{de}$	$10.30±0.10^{f}$	$20.10±0.10^{b}$	$24.20±0.20^{a}$	$24.20±0.20^{a}$	$15.57±4.99^{de}$	$16.30±0.30^{cd}$
PCV (%)	$20.00±1.00^{j}$	$28.00±1.00^{ef}$	$23.00±1.00^{hi}$	$27.00±1.00^{fg}$	$27.00±1.00^{fg}$	$31.00±5.20^{bc}$	$33.00±1.00^{ab}$
Hb (g/dl)	$6.60±0.20^{h}$	$9.30±0.10^{ef}$	$7.30±0.10^{h}$	$9.00±0.00^{fg}$	$9.00±0.00^{fg}$	$10.30±1.73^{cd}$	$11.00±0.10^{bc}$
MCV(fl)	$83.97±11.21^{bc}$	$84.93±9.63^{bc}$	$82.13±0.65^{bc}$	$87.10±0.40^{b}$	$87.10±0.40^{b}$	$93.13±17.72^{ab}$	$82.50±0.40^{bc}$
MCH (pg)	$27.67±3.15^{bcd}$	$28.30±4.09^{bcd}$	$26.10±1.30^{cd}$	$29.03±0.95^{bc}$	$29.03±0.95^{bc}$	$30.97±5.83^{ab}$	$27.53±0.95^{bcd}$
MCHC (%)	$33.03±0.65^{a}$	$33.23±1.55^{a}$	$31.77±1.80^{a}$	$33.33±1.25^{a}$	$33.33±1.25^{a}$	$33.20±0.00^{a}$	$33.37±1.30^{a}$

Figure 2: Weekly Growth Performance of the Experimental Fish

Discussion

The water quality parameters measured in this study were within the optimal recommended range as observed by Afia and Ofor (2016) the temperature of fish changes according to its environment which affect metabolism, dissolved oxygen is needed to aid aerobic generation of energy for body maintenance and physiological functions of aquatic organisms. According to Fagbenro *et al* (2013) haematological Parameters on catfish species are to determine their health status with well establish ranges. The RBC count were in disagreement with Eyiwumi *et al* (2018). The latter reported that decrease in low RBC were due to decrease in inclusion levels of Moringa Leaf Meal (MLM) while in this research the lower RBC were within the medicinal diets processed with hexane solvents for 3% and 5% inclusion level (Table 2) and may be as a result of non-polar nature of the hexane solvent.

The Increased values recorded in WBC count contributed to the better survival rate of the experimental fish in this study and were in agreement with Eyiwumi *et al* (2018) who discovered that 15% MLM diet recorded high increase in WBC and Lymphocyte count increases fish survival rate which also increases the iron content of the diet fed as major sources of Haemoglobin in the fish diets. WBC are the defence cells of the fish body. Therefore, the increase recorded attributed to increase in leucocytes synthesis as defence mechanism against the destruction of erythrocytes (Oniya *et al*., 2013; Afia and Ofor, 2016; Suleiman *et al*., 2018). All the PCV counts recorded in this study may likely be as a result of sign of healthier fish with high immunity which is an indication that the increase in PCV of fish under study had high immunity or resistance anaemic condition. The values recorded for the experimental based diets were higher than control-based diets and were in opposition to Eyiwumi *et al* (2018) who reported low PCV counts on fish fed experimental diets of 0.5% and 1% MLM inclusion levels. The highest MCV (104.77±0.25 fl) was recorded in 3% Eucalyptus Hexane (EHX) based diet which was also an indication that the fish under study had high immunity or resistance to disease (Fagbenro *et al*., 2013). It however concluded that 3% and 5% inclusion levels of medicinal processed diet both have similar haematological positive impact on *Clarias gariepinus* but 3% is recommended for use due to the growth performance of the fish measured during the study.

References

Adeleke, B., Anderson, R. D., Moodley, G. and Taylor, S. (2021). Aquaculture in Africa: A comparative Review of Egypt, Nigeria and Uganda Vis-Avis South Africa. *Fisheries Science and Aquaculture.* 29:2, 167-197

Afia, O. E. and Ofor, C. O. (2016). Haematological Indices of the *Clarias gariepinus* X *Heterobranchus longifilis* (Hybrid Catfish - Heteroclarias) Reared at Different Feeding Levels. *Nigerian Journal of Agriculture, Food and Environment.* 12(3):6-11

Anjusha, K. V, Mamun, M. A. A., Dharmakar, P., & Shamima, N. (2019). Effect of Medicinal *Herbs on Hematology of Fishes*. *8*(09), 2371–2376.

Argungu, L. A., Siraj, S. S., Christianus, A., Amin, M. S. N., Abubakar, M. S., & Abubakar, I. A. (2017). A Simple And Rapid Method for Blood Collection From Walking Catfish , *Clarias batrachus (Linneaus , 1758)*. *16*(3), 935–944.

Chakraborty, S. B., Hancz, C., Chosal, I. and Deborsee, M. (2018). Dietary Administration os Plant Extracts for Production of Monosex Tilapia: Searching a Suitable Alternative to Synthetic Steroid in Tilapia Culture. *Turkish Journal of Fisheries and Aquatic Sciences., 18*, 267-275.

Ezearigo, O., Adeniji, P., & Ayoade, F. (2014). Screening of natural spices for improving the microbiological, nutritional and organoleptic qualities of the *Zobo* drink. *Journal of Applied Biosciences*, *76*(1), 6397. https://doi.org/10.4314/jab.v76i1.10

Fagbenro, O. A., Adeparasu, E. O. & Jimoh, W. A. (2013). Haematological Profile of Blood of African Catfish (Clarias gariepinus, Buchell, 1822) Fed Sunflower and Sesame Meal Based Diets. *Jcademic Journal of Fisheries and Aquatic Science*, *8*(1), 80–86.

Fauci, A. S. (1993). Multifactorial Nature of Human Immunodeficiency Virus Disease: Implications for

Therapy. science-new york then Washington. 262:1011-1011.

Grant, K. R. (2015). Fish Haematology and Associated Disorders. Veterinary Clinics: Exotic Animal Practice. 18(1): 83- 103

Halwart, M. (2020). Fish Farming High on the Food System Agenda in 2020. FAO Aquaculture. *Newsletter*.61:II-III google scholar.

Kelly, W. R. (1979). Veterinary Clinical Diagnosis (2nd Edition). In *Balliere, Tindall, London.* (Issue 2).

Jimoh, A. A. Yusuf, O. A., Lanre-Bhadmos H Y. O. and Ashaolu E. T. (2022). Growth, Haematology, Nutrient Retention and Histology of African Catfish, *Clarias gariepinus* Fingerlings Fed Larvae of *Musca domestica*. *Ife Journal of Agriculture*, *34*(1), 122–142.

Suleiman, A.M., Orire, A. M, and Sadiku, S. O. E. (2018). Effects of Moringa oleifera Leaves, Bark Stem of Lannea barteri and Antibiotic (Oxytetracycline) on Haematological Parameters of Clarias gariepinus Fingerlings. *Fisheries and Aquaculture Journal*, *09*(02). https://doi.org/10.4172/2150-3508.1000246

Ochang, S. N., Peter, B. M., Ugbor, O. N. & E. A. (2015). Effect of Diets With Moringa Leaf Meal on Growth, Carcass Composition and Haematology of Clarias gariepinus. *International Journal of Fisheries and Aquatic Studies.*, *3*(2), 397–401.

Suleiman, A. M., Orire, A. M., & & Sadiku, S. O. E. (2018). Impacts of Moringa oleifera leaves and Lannea barteri bark as growth promoting additives and survival rates in the diets of Clarias gariepinus fingerlings. *Journal of Fisheries Research*, *02*(02). https://doi.org/10.35841/fisheries-research.2.2.12-16

70 ASSESSMENT OF INORGANIC FERTILIZER ON FRESHWATER FISH CULTURE IN NIGERIA

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ABSTRACT

Inorganic fertilizers when applied to aquaculture ponds have great potentials in boosting fish production. Pond Fertilization makes available higher concentrations of nitrogen, phosphorus, and other plant nutrients for inducement of phytoplankton photosynthesis which forms the base of the food web enhancing fish production. The research was carried out to assess the performance of Inorganic fertilizer on freshwater fishponds. The N.P.K (15:15:15) fertilizer and the post–fries of Clarias gariepinus with initial mean weight of 0.045kg were used for the bi-weekly experiment which lasted six weeks. Six Aquaria (tanks) each with an area of 60cm^2 X 30cm^2 X 30cm^2 and the depth of 12.10cm were used. Three out of six tanks were fertilized with N.P.K 15:15:15 at 0.05kg/ha and the other three remained unfertilized and served as control experiment. At the end of the experiment, one-way ANOVA and Duncan Multiple Range Tests showed that, the Physico-chemical parameters in fertilized tanks were significantly higher ($P<0.05$) than the unfertilized tanks for the period of six weeks and in terms of length-weight performances. Based on this analysis, it proved that pond fertilization with inorganic fertilizer could bring faster fish growth than unfertilized pond which would go a long way in enhancing and boosting fish culture and then recommended this good scientific and experimental ideology to fish farmers.

Keyword: Fertilized/unfertilized Aquaria, Inorganic Fertilizer (NPK 15:15:15), Assessment, Catfish post-fries, Physico-chemical parameters

INTRODUCTION

Fish culture principally aims at producing high quality fish food for human consumption, and providing sufficient fingerlings to restock open waters and ponds. Fish culture also provides additional income to farmers and their families thereby alleviating poverty particularly among the rural populace (Bamidele, 2007; Oladele, 2010; Boyd, 2018). The quest to enhance protein level and supply to Nigerian people has mandated putting into use all available waters for rearing fishes of different species (Gamal *et al*. (2014). Through the use and application of fertilizer, the unfit waters for aquaculture can be made fit and suitable for fish culture (Sebastian, 2015). This is made possible because fertilizer application enhances pond primary productivity which directly or indirectly will serve as a boost to fish production. (Boyd, 2018). Planktons are good supplements to artificially formulated feed because fertilized ponds are able to turn out fishes that will reach market sizes in few months, thereby fulfilling the sole aim of aquaculture which is profit maximization in fish production (Adigun, 2005; Ovie, *et al*., 1993; Adeyemo, *et al*., 1994; Oladele, 2010).

It has been observed that the continuous utilization of fishponds for rearing fish usually results to removal of nutrients causing low fertility. The physico–chemical parameters will also be affected beyond the range for aquaculture practice. Several studies have indicated the great performance of fish production through the abundance of plankton (Ovie, *et al*., 1993; Oladele, 2010). But the unfertilized ponds remain less productive because of the unavailability of plankton. The research was carried out to assess the influence of inorganic fertilizer on Nigerian freshwater fish culture. There is an urgent need to increase fish production through the application of inorganic fertilizer. These fertilizers contain a good combination of nitrogen and phosphorus in different proportions which increase the quantity of primary producers (Kumar *et al.,* 2014). The study compares the water quality properties of the unfertilized and fertilized aquaria and the fish Length and Weight improvement within the period of six weeks.

MATERIALS AND METHODS

The Research was carried out at the Federal University of Technology Fisheries Laboratory, at Bosso in Minna, Niger State, Nigeria. The N.P.K (15:15:15) fertilizer for the experiment was bought from Minna Central market, while the post–fries of *Clarias gariepinus* with initial mean weight of 0.045kg were sourced from the university fish farm. Six Aquaria (tanks) each with an area of $60cm^2$ X $30cm^2$ X $30cm^2$ and the depth of 12.10cm were used. The tanks were supplied with well water and three out of six tanks were fertilized with N.P.K 15:15:15 at 0.05kg/ha and the other three remained unfertilized and served as control experiment. The species used were *Clarias gariepinus.* Initially *Clarias* post fries were fed with supplementary diet of Artemia feed at 30% of their body weight twice daily and later changed to 0.2 – 0.5mm size of Coppen feed. The tanks subsequently received biweekly application of fertilizer after complete draining of the tanks and refilling with fresh water. The Physico–chemical parameters in all the experimental tanks were measured using the same method. Temperature, Dissolved Oxygen level, pH, conductivity, Hardness and Total Alkalinity were measured one day before and after the tanks biweekly re–fertilization. Temperature measurements were taken in the morning and evening of the same day of water analysis, while the fish growth were monitored biweekly coinciding with re–fertilization days.

RESULTS

Table 1 shows inter–relationship of the various parameters between fertilized and unfertilized water coupled with Length – weight performance. It helps to explain the summary of the mean values and significant differences of physico–chemical properties and the Length -Weight Fish performance both in the fertilized and unfertilized water. The physico – chemical parameters subjected to these analyses are pH, Conductivity, Hardness, Total Alkalinity, Dissolved Oxygen and also the Length – Weight Fish performance in the fertilized and unfertilized tanks.

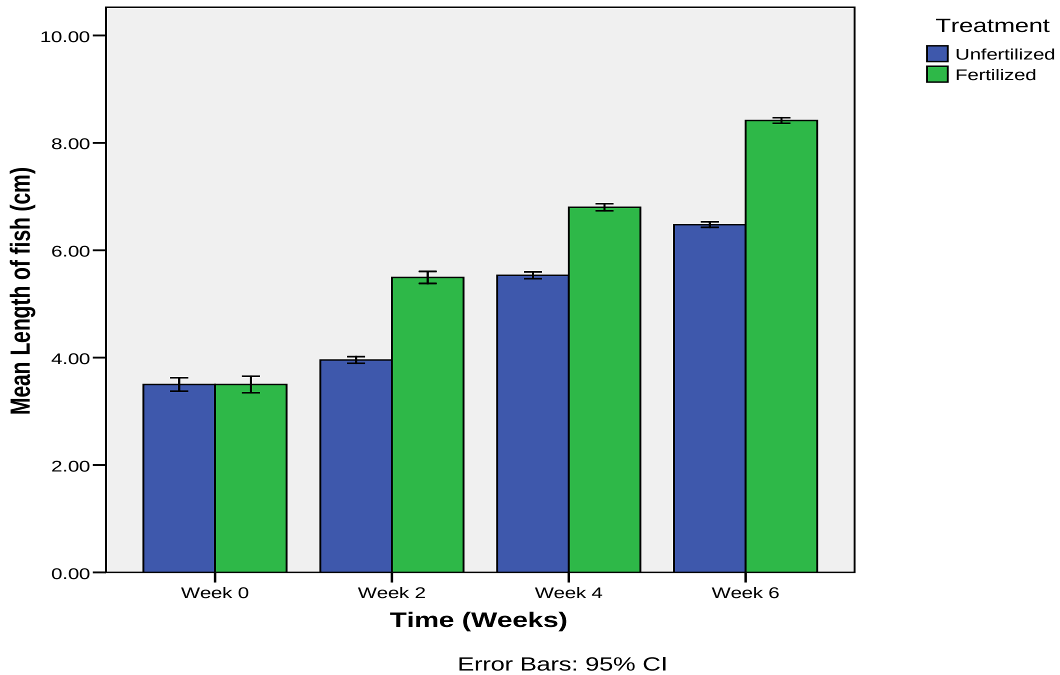

Figure 1: Mean Length (cm) of fish of the fertilized and unfertilized aquaria

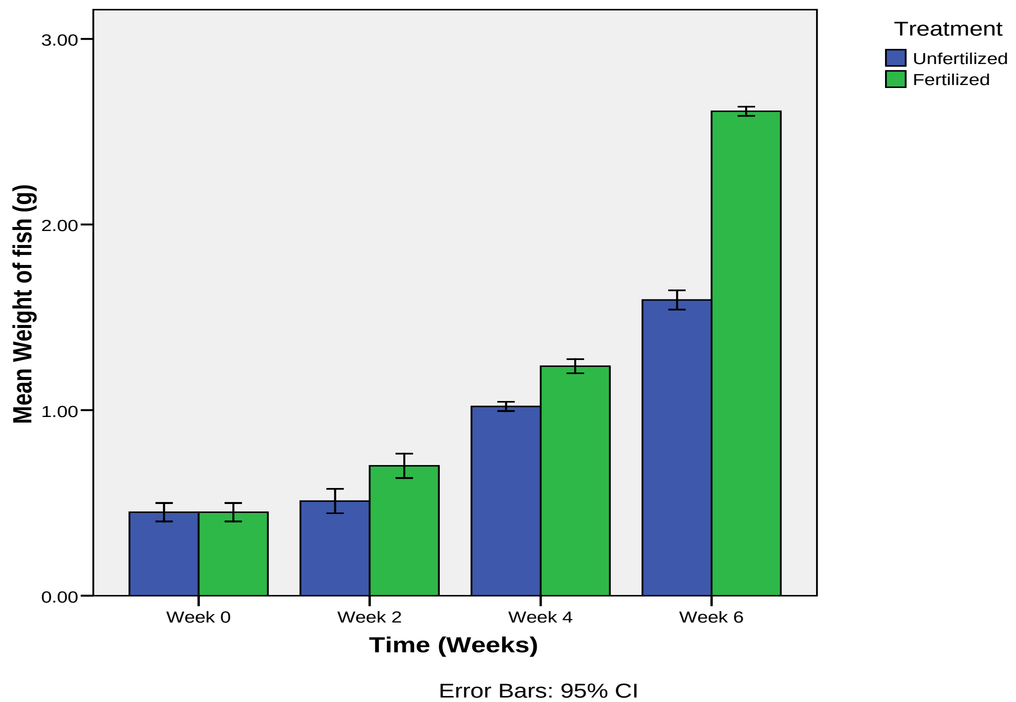

Figure 2: Mean Weight of Fish (g) of the fertilized and unfertilized aquaria

Table 1: Total Summary of the Physico – Chemical Parameters and Length – Weight Fish Performance of fertilized and unfertilized Aquaria

TIMES (weeks)/ Properties	0	2	4	6	Average
pH					
Unfertilized	7.17±0.015[a]	6.86±0.199[a]	7.07±0.020[a]	6.90±0.021[a]	7.00±0.155[a]
Fertilized	6.73±0.208[b]	6.85±0.050[a]	6.60±0.010[b]	6.88±0.030[a]	6.77±0.148[b]
Sig.	0.023*	0.916	0.000*	0.330	0.001*
Conductivity(µs/cm) Unfertilized					
Fertilized	146.40±0.700[b]	582.67±15.535[b]	703.33±1.528[b]	370.67±1.155[b]	450.77±221.815[b]
Sig.	1574.00±1.000[a]	4530.00±10.000[a]	3440.00±62.450[a]	3046.67±20.817[a]	3147.67±1106.085[a]
	0.000*	0.000*	0.000*	0.000*	0.000*
Hardness (mg/l) Unfertilized					
Fertilized	86.00±2.000[a]	108.33±2.082[a]	85.00±1.000[b]	85.73±0.643[a]	91.27±10.38
Sig.	76.07±0.0306[b]	92.00±0.200[b]	150.07±0.306[a]	74.00±0.400[b]	98.03±32.21
	0.001*	0.000*	0.000*	0.000*	0.496
Total alkalinity (mg/l) Unfertilized					
Fertilized	108.00±4.000[b]	106.67±6.110[b]	86.67±6.123[b]	31.20±1.114[b]	83.13±32.79
Sig.	116.07±2.403[a]	151.93±0.503[a]	165.33±4.163[a]	140.33±1.528[a]	143.42±19.03
	0.040*	0.000*	0.000*	0.000*	0.000*
Dissolved oxygen (mg/l)					
Unfertilized	6.93±0.503[a]	9.33±1.153[a]	7.33±1.155[a]	4.00±0.400[b]	6.90±2.130
Fertilized	5.07±0.115[b]	8.40±0.200[b]	3.00±1.000[b]	7.67±0.200[a]	6.01±2.27
Sig.	0.003*	0.033*	0.002*	0.000*	0.218
Temperature (^{0}C) Unfertilized					
Fertilized	24.90±1.054[a]	26.04±0.055[a]	24.23±0.058[b]	24.03±0.058[a]	24.80±0.933
Sig.	26.50±0.600[a]	26.10±0.100[a]	25.07±0.513[a]	24.27±0.252[a]	25.48±0.982
	0.084	0.391	0.049*	0.193	0.095
Length of fish (cm) Unfertilized					
Fertilized	3.50±0.050[a]	3.96±0.025[b]	5.53±0.025[b]	6.48±0.021[b]	4.87±1.251
Sig.	3.50±0.062[a]	5.49±0.045[a]	6.80±0.026[a]	8.42±0.021[a]	6.05±1.882
	0.000*	0.000*	0.000*	0.000*	0.083
Weight of fish (g) Unfertilized					
Fertilized	0.45±0.020[a]	0.51±0.026[b]	1.02±0.010[b]	1.59±0.021[b]	0.89±0.482
Sig.	0.45±0.020[a]	0.70±0.026[a]	1.24±0.015[a]	2.61±0.010[a]	1.25±0.872
	1.000	0.001*	0.000*	0.000*	0.229

Key* significantly different at 95% confidence ($p<0.05$) values with the same letter are not significantly different from each other ($p>0.05$) values with different letter are significantly different from each other. R: replicate

In Table 1, one–way ANOVA showed that the average pH of the unfertilized water of neutral pH 7.0 was significantly higher than that of the fertilized water of slightly acidic pH 6.77. The average conductivity of the fertilized water (3147.67µs/cm) was significantly higher than that of the unfertilized water source (450.77µs/cm). The average total alkalinity (mg/l) of the fertilized water (143.42) was significantly higher than that of the unfertilized water (84.13). The average dissolved oxygen for the whole week was insignificantly higher in the unfertilized water than the fertilized water. At week 4, the temperature of the fertilized water was significantly higher than that of the unfertilized water. Figure 1 shows the relationship between the length of fish (cm) and the period of growth (week) of the fish of the two treated water. Duncan multiple range test showed that at weeks 2, 4 and 6 the length of fish in fertilized water (5.49 cm, 6.80 cm and 8.42 cm respectively) were significantly higher than that of the unfertilized water (3.96cm, 5.53cm and 6.48cm respectively). At week 0, the fish had same length 0.45cm. Figure 2 shows the relationship between the weight of fish and period of growth of the fish in weeks of one treated water and untreated water. Duncan multiple range test showed that at weeks 2, 4 and 6, the weight of fish in the fertilized water (0.70g, 1.24g and 2.61g respectively) were significantly higher than those in the unfertilized water (0.51g, 1.02g, and 1.59g respectively).

DISCUSSION

The average pH of 6.77 in fertilized pond was high but better than the unfertilized tanks. The higher pH value recorded in fertilized pond is in line with Boyd (2018) who reported that the application of ammonium and urea-based fertilizers can cause acidification of pond water because of nitrification, which produces two hydrogen ions from each ammonium ion. In conclusion Duncan multiple range tests showed that the weights of fish in the fertilized tanks in all the weeks of the experiment were significantly higher than the unfertilized tanks. This totally agrees with Craig and Charles (2016) that fertilized ponds can have fish yields three to four times over that of the unfertilized ponds. Duncan multiple range test also showed that at weeks 2, 4 and 6 the length of fish in fertilized water (5.49 cm, 6.80 cm and 8.42 cm respectively) were significantly higher than that of the unfertilized water (3.96cm, 5.53cm and 6.48cm respectively). This agrees with Sebastian (2015) who reported that the specific growth rate of *Clarias gariepinus* fries were observed to be better in tanks fertilized compared to unfertilized tanks under both stocking density. Sebastian (2015) also said that the addition of manures and fertilizers to the fishponds improve the level of Phytoplankton responsible for fish growth. That goes to say that the positive impact of fertilizer on fish production cannot be over emphasized. It can be observed that fertilizer plays a very important role in inducing the production of planktons which are fish food organisms and hence promoting fish growth, thereby enhancing high productivity in production. The use of fertilizer for generating plankton for fish production is suitable for fish farmers most especially poor resources-based fish farmers who have no financial capacity to purchase the artificially processed feed in adequate quantity that can sustain and enhance their fish culture. Since the purpose of aquaculture generally is to make profit, fertilizer applied to the pond obviously reduces the cost of feeding and this will help the fish farmer to make more profit in the farm business

References

Adeyemo, A.A.; Oladosu, G.A and Ayinla, O.A (1994). Growth and survival oof Fry of Afican Catfish Species *clarias gariepinus* Burchell, *hererobranchus bidorsalis* Goeffery and *heteroclarias* reared on *moina dubia* in comparison with other first feed sources Aquaculture. 119: 41 – 45.

Adigun, B.A (2005). Water Quality Management in Aquaculture and Freshwater Zooplankton Production for Use in Fish Hatcheries, Alabi Printing Press, Nigeria

Bamidele, O.O (2007). Introduction to Fish Farming in Nigeria. Ibadan University Press, University of Ibadan. 88pp]

Boyd, C. E. (2018). Aquaculture pond Fertilization. Journal of Agriculture, Veterinary Science Nutrition and Natural Resources. April 2018

Craig Watson and Charles E. Cichra Fertilization of Fresh Water Fish Ponds U.S. Department of Agriculture, UF/IFAS Extension Service, University of Florida, IFAS, Florida A & M University Cooperative Extension Program, and Boards of County Commissioners Cooperating. Nick T. Place, dean for UF/IFAS Extension.

Oladele, S. M. (2010). The Influence of Fertilizer to Freshwater Fish Culture (B. Tech.) Project, Federal University Of Technology, Minna, Niger State

Ovie, S.I.; Adeniji, H.A. and O.I. Olowe (1993). Isolation and Growth Curve Characteristics of a Freshwater Zooplankton for Feeding Early Larvae and Fry Stages of Fish. Journal Aqua. Tropical 8:181 – 196.

Gamal, O.E., Ibrahim, N.A. and Abou-Zead. M.Y. (2014). Influence of fertilizer's types and stocking density on water quality and growth performance of Nile tilapia- African catfish in Polyculture system. *8th International Symposium on Tilapia in Aquaculture*, World Fish Center, Egypt. (pp.151-171). Available at http://cals.arizona.edu/azaqua/ista/ISTA8/NabilIbrahem.pdf [Accessed on 2nd April, 2014]

Kumar, A., Sharma, L.L. and Aery, N.C. (2008). Physicochemical Characteristics and Diatom as Indicators of Trophic Status of Kishore Sagar, Rajasthan. In: Sengupta, M. and Dalwani, R. (Eds.) *Proceedings of Taal 2007: The 12th World Lake Conference*, India. (pp. 1804-1809). Available at http://www.moef.nic.in/sites/default/files/nlcp/Indian%20Case%20Studies/Q-4.pdf [Accessed on 17th June, 2014

Sebastian, S. M. (2015) Effect of Organic and Inorganic Fertilizers on Natural Food Composition and Perfomance of African Catfish (*Clarias gariepinus*) Fry produced under Artificial Propagation Msc. (Aquaculture) Thesis Lilongwe University Of Agriculture And Natural Resources Bunda Campus, Tanzania.

71 UTILIZATION OF MAIZE BRAN CHEMICAL HYDROLYSATE USING MINERAL ACID IN THE PRATICAL DIETS OF Clarias gariepinus

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Abstract

The study was carried out to ascertain utilization of maize bran chemical hydrolysate using mineral acid in the practical diets of Clarias gariepinus. Two hundred and twenty five fingerlings of Clarias gariepinus was used in a complete randomized design. Five experimental diets were used. Whole Maize Meal (WMM), Maize Starch (MS), Maize Bran (MB), Hydrolysed Maize Bran (HMB) and commercial feed as the control. The fish were weighed and stocked at 15 fishes per tank for the treatments in triplicates. The fishes were fed three times daily and bulked weighed forth nightly. They were fed to satiation for 56 days. Data on growth performance and utilization was collected and analyzed by one way analysis of variance. No Significant difference was observed for the Mean Weight gain, The Apparent net protein utilization (ANPU) and protein efficiency ratio (PER) for diet 1, 3 and diet 4 but diet 5 had a significantly high value ($p<0.05$) while diet 2 has significantly ($p<0.05$) low value. It was concluded that maize bran hydolysates can be utilized in Clarias gariepinus. However, Maize Bran Hydrolysates was utilized but at a lower rate comparing with commercial feed and their use in fish feed could address the challenge of high cost of fish feed.

Keywords; Growth Performance, Utilization, Hydrolysate, Maize Bran, *Clarias gariepinus*

Introduction

The total production of aquafeeds for all aquaculture species is predicted to increase by 75% from 49.7 million tons in 2015 to 87.1 million tons in 2025 (Tacon, 2015). Maize is a common energy source in formulated feeds for fish like *Clarias gariepinus*. Maize is one of the major sources of metabolizable energy in most compounded diets for catfish species and this is because it is readily available and digestible. In recent times, the global pandemic and high rate of insecurity in Nigeria has given a hike in cost of plant source and ingredients used in feed formulation for fish especially the use of maize. Maize Bran which is removed during processing of whole maize or maize starch is highly fibrous and contains celluloses, hemicelluloses and lignin which monogastric such as fish cannot digest (Haghighi, 2018). It is often discarded, given to ruminants, poultry birds or allowed to waste away. More so, these by-products are currently not only underutilized but many times represent a disposal problem which compromises environmental sanity. However, hydrolyzing maize bran and incorporating them into fish diets could enhance their digestibility and utilization in the body *of Clarias gariepinus* and achieve zero waste in feed formulation.

Materials and Methods

Experimental System

The experiment was conducted in a recycling water system of the Department of Water Resources, Aquaculture and Fisheries Technology laboratory of School of Agriculture and Agricultural Technology, Federal University of Technology, Minna, Gidan Kwano Campus, Niger State, Nigeria. A total of five (5) treatments were used, five (5) treatments in triplicates of maize meal (MM), Maize Starch (MS), maize bran (MB), chemically hydrolysed Maize Bran (HMB) and commercial reference control diet (CRCD). The experimental design used is complete randomized design (CRD) with one fish per liter in a 15-liter tank.

Experimental Fish

Total of (225) fingerlings of *Clarias gariepinus* were purchased from Tagwai Fish Farm, Niger State and transported to the Department of Water Resources, Aquaculture and Fisheries Technology (WAFT) laboratory. As feeding trial commenced, fish at fingerling stage was weighed and stocked at 15 fishes per tank for the five treatments in triplicates. The fishes were fed three times daily between the hours of 8am, 12pm and 4pm. The fishes were bulked weighed forth nightly and at the end of experiment, all fishes were weighed and counted individually of which five was selected for the determination of final whole-body composition. The duration of experiment was for 56 days (8 weeks). The fish were fed to satiation and their percentage body weights were adjusted bi weekly to fit into their satiation level.

Experimental Feed and Preparation of Hydrolysed Maize Bran

The feed ingredients were purchased from Minna, Central Market, Niger State which includes fish meal, groundnut cake, maize and vitamin mineral premix. The maize bran extracted from whole maize was processed further after by adding 1.25% of Sulphuric acid in a ratio of solid to liquid of 1:4. 100g of maize bran was weighed and soaked into 400ml of 1.25% Sulphuric acid solution and boiled for 30 minutes. Thereafter, the mixtures were washed thoroughly and 400mls of sodium hydroxide was added to the washed mixture and then boiled for another 30 minutes to stabilize the pH and washed after boiling. The hydrolysed bran was sieved and used for formulation of feed.

Feed Formulation and Diet Preparation

Using the equational method of feed formulation, five diets were formulated at 40% crude protein (CP). The diets are Diet I Whole Maize Meal (MM), Diet II Maize Starch (MS), Diet III, Maize Bran (MB), Diet IV Hydrolysed Maize Bran (HMB).

Proximate Analysis and Statistical Analysis

The experimental diet were analysed to check for proximate composition according to A.O.A.C

2005. The data obtained was subjected to one way analysis of variance (ANOVA) using Turkey's test (Steel, 1981) at 5% probability level. Multiple parameters mean comparison of treatments will be according to Duncan multiple range tests (Duncan, 1955) using the software SPSS 23.

Results

The mean initial weight (MIW) of the experimental fishes for all diets were not significantly different ($p>0.05$). There was no significant difference ($P>0.05$) observed for the mean final weight for Diet 1(11.48g),3(10.67g), 4(11.14g) but diet 5 had a significantly high value ($p<0.05$) of 31.89g while diet 2 has significantly ($p<0.05$) low value of 8.87g and it was same with their Mean Weight gain, The Apparent net protein utilization (ANPU) as well as protein efficiency ratio (PER) as seen in table 4. The Specific growth rate was significantly high ($p<0.05$) for the control diet 5 (5.17%/day) while there was no significant difference between diet 1 (3.33%/day), 2(2.88%/day), 3(3.21%/day) and diet 4(2.95%/day). The survival rate had no significant difference ($p>0.05$) between diet 3(86.66%), diet 4(86.66%) and diet 5(86.66%) while there was no significant difference ($p>0.05$) between diet 1(76.65%) and diet 2 (70%) in table 4

Discussion

The growth performance and utilization of diet 1, diet 3 and diet 4 for MWG, SGR, FCR, ANPU was with no significant difference ($p<0.05$) but positive as feed was utilized. There was a high significant growth ($p>0.05$) in control diet 5 which gave the best result possibly because of its superiority over the experimental diets. This result agrees with the report of (Olaniyi 2009 a&b) who indicated that the higher the SGR and the smaller the FCR values, the better the feed quality. Diet 2 had lower values for MWG, SGR, and PER. Alegbeleye *et al*., (2008) reported significant decrease in weight gain when maize was replaced with corn flour (*Colocassia esculenta*). The high survival rate in this study indicates that feeding *Clarias gariepinus with HMB* does not lead to mortality of fish. The nutrient quality, which translated into good growth in the fish fed with HMB could be as a result of the processing method adopted.

Conclusion

It was therefore concluded that maize bran hydolysates can be utilized in the feed of *Clarias gariepinus*. However, Maize Bran Hydrolysates performed and was utilized but at a lower rate comparing with commercial feed. The use of maize bran hydrolysates in fish feed will address the challenge of high cost of fish feed and also help the environmental challenge of bran disposal in the environment.

Table 1: Proximate Composition of Feed Ingredients

Proximate(%)	Fish Meal	GNC	Maize	Maize Starch	Maize Bran	HMB
Crude Protein	60.38	30.62	11.00	4.81	10.06	10.06
Crude Fibre	0.05	1.25	0.45	0	6.80	0
Crude Lipid	19.73	31.08	8.14	0.8	3.86	0.8
Ash	6.70	7.35	1.4	0.05	0.35	1.2
Moisture	6.87	3.52	7.45	2.95	1.24	7.34
NFE	6.27	26.18	71.45	91.39	60.36	80.6

Table 2: Composition of experimental diets fed *Clarias gariepinus* for 56 days

Ingredients	Diet 1	Diet 2	Diet 3	Diet 4
Fish Meal	8.39	8.56	8.42	8.42
GNC	75.59	76.99	75.76	75.62
Whole Maize	11.02	0.00	0.00	0.00
Maize Starch	0.00	9.45	0.00	0.00
Maize Bran	0.00	0.00	10.82	0.00
HMB	0.00	0.00	0.00	10.82
Vitamin Premix	5.00	5.00	5.00	5.00
Total	100	100	100	100

Table 3: Chemical composition and proximate analysis of the formulated diets

Proximate	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5
CP	40.16	40.09	40.07	40.11	40
Ash	14.8	14.6	14.20	15.65	8.00
Lipid	13.88	12.30	12.44	12.6	12.00
Fiber	2.5	1.16	6.67	1.83	4.00
Moisture	4.62	5.2	4.76	6.74	3.42
NFE	24.12	26.65	21.86	23.07	32.58

Table 4: Growth Parameters and Nutrient Utilization of Experimental Diets fed *Clarias gariepinus* fingerlings for 56 days

Growth Parameters	Diet 1 (WMM)	Diet 2 (MS)	Diet 3 (MBM)	Diet 4 (HMB)	Diet 5 (CRCD)	SD±
MIW(g)	1.76±0.01	1.76±0.02	1.76±0.01	1.77±0.01	1.7±0.2	0.01
MFW(g)	11.48±0.43^{b}	8.87±0.41^{c}	10.67±0.19^{b}	11.14±0.71^{b}	31.89±0.82^{a}	0.55
MWG(g)	9.71±0.42^{b}	7.11±0.42^{c}	8.92±0.18^{b}	9.37±0.72^{b}	30.14±0.82^{a}	0.56
SGR(%/Day)	3.33±0.06^{b}	2.88±0.09^{b}	3.21±0.03^{b}	2.95±0.59^{b}	5.17±0.05^{a}	0.27
FCR	2.48±0.05^{b}	3.70±0.83^{a}	2.45±0.04^{b}	2.30±0.11^{b}	0.9±0.03^{c}	0.37
PER	1.00±0.01^{b}	0.69±0.17^{c}	0.99±0.00^{b}	1.08±0.06^{b}	2.76±0.08^{a}	0.09
ANPU(%)	38.1±0.70^{b}	28.98±5.94^{c}	39.00±2.19^{b}	43.84±2.08^{b}	133.30±6.90^{a}	4.30
Survival(%)	76.65±3.35^{b}	70.00±10.00^{b}	86.66±0.00^{a}	86.66±0.00^{a}	86.66±0.00^{a}	4.72

KEY: MIW: Mean Initial Weight; MFW: Mean Final Weight; MWG: Mean Weight Gain; SGR: Specific Growth Rate; FCR: Feed Conversion Ratio; ANPU: Apparent Net Protein Utilization; PER: Protein Efficiency Ratio and SD: Standard Deviation. WMM: Whole Maize

Meal; MS: Maize Starch; MBM: Maize Bran Meal, HMB: Hydrolysed Maize Bran, CRCD: Commercial Reference Control Diet.

References

Alegbeleye WO, Olude O Nusiat R (2008). Effect of feeding Colocasia [*Colocasiaesculenta* (L) Schott] Corn flour as a part of energysupplement on growth and Nutrient utilization in *Clarias gariepinus* (Burchell, 1822) fingerlings. Proceeding of the 23rd Annual conference of FISON,14:22-30

AOAC, (2005). AOAC Official Methods of analysis. 18th ed. *Association of official Analytical Chemist*, Gaithersburg, MD, USA.

Duncan, D.B. (1955). New Multiple Range Test Biometrics 11:1-42.

Haghighi Manesh S, Azizi MH (2018). Integrated extrusion-enzymatic treatment of maize bran for production of functional cake. *Food Sci Nutr*. 2018;6:1870–1878. https://doi.org/10.1002/fsn3.738 *of Clarias gariepnus fed processed Mucuna seed meal*. In Proceeding 34th Annual Conference, Nigerian Society

Olaniyi, C. O., Bini Omote, T., & Gbadamosi, M. (2009a). *Growth Performance and Nutrient Utilization of*

Clarias gariepnus fed processed Mucuna seed meal. In Proceeding 34 Annual Conference, Nigerian Society for Animal Production (pp. 222-225).

Olaniyi, C. O., Bini Omote, T., & Gbadamosi, M. (2009a). *Growth Performance and Nutrient Utilization*

Performance and nutrient utilization of *Clarias gariepinus* fed locust bean seed meal. In Proceedings of 14th Annual Conference, Animal Science Association of Nigeria (ASAN) (pp. 550-552).

Steel, R.D. and Torie, J. H. (1981). Principles and procedures of statistics. A Biometrical Approach. 2nd edn. McGraw-Hill International, Auckland. 102 pp.

Tacon Albert G. J. & Marc Metian, (2015) Feed Matters: Satisfying the Feed Demand of Aquaculture, Reviews

in Fisheries Science & Aquaculture, 23:1, 1-10, DOI: 10.1080/23308249.2014.987209.

72 SENSORY AND PROXIMATE COMPOSITION OF 'BISCUIT' PRODUCED FROM SOME LESS VALUED DRIED FISH POWDER

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Abstract

An experiment was conducted to evaluate the proximate and sensory properties of 'Biscuit' made using fish protein concentrate from some less valued dried fish powder. The experiment consists of five treatments substituted with dried fish powder at varying proportions (100:0; 99.5:0.5; 98:2; 96.5:3.5; 95:5) with wheat flour replicated 3 times. The 'Biscuit' was produced based on the prepared composite flour. The experiment was conducted to evaluate the sensory evaluation, proximate composition, shelf life and microbial load of the product. The result obtained indicated that there was significant difference in terms of sensory evaluation during the storage period while in the proximate composition, there was significant difference in the protein content, and there was also significant difference in all other parameters. From the result obtained from this research, treatment III and IV are recommended because they had high acceptance in terms of taste, texture, appearance, and odor.

Keywords: Biscuit, Chemical, Organoleptic, Sensory,

Introduction

Fish is an essential source of high-quality protein (Ohen&Abang, 2007), providing about 16% of animal protein consumed by the world's population. It provides 40% of the dietary intake of animal protein of the average Nigerian (, 1997). It contains lysine as well as vitamin A that is necessary for healthy growth. It contains some quantities of calcium, phosphorus, fat, and other nutrients needed for human growth and health (FAO, 2003).

Large quantities of fin fish/shellfish are thrown out at the landing site due to non-patronage by most people which makes it uneconomical to preserve and bring them ashore (Subhendu, 2013). A large proportion of the total landed fish remain unused due to inherent problems related to unattractive color, flavor, texture, small size, and high fat content. Most of these underutilized fish belong to the abundantly available pelagic species, which are by-catch of some unconventional species. It was felt that making use of these less valued fish and incorporating the dried fish powder in a daily carbohydrate food such as "Biscuit", chin-chin, cake, and fish piecould alleviate the problem, facilitate the consumption of less valued fish by incorporating it in form of fish value addition. The aim of this study is therefore, to evaluate the chemical, microbial and sensory parameters of fish Biscuit.

Materials and Methods

Experimental site

The experiment was conducted at the Processing Unit, Department of Fisheries and Aquaculture located at the main campus of Usmanu Danfodiyo University, Sokoto (N 13º 07' 45.12'' E5º 12' 18''). The area is within the Sudan savannah agro-ecological zone of Nigeria whose climate is characterized by a long dry season from November to May and a short rainy period from June to September (Mamman*et al*., 2000).

Sample collection

Fresh fish samples of less valued fishof 5kg were purchased from KasuwarDankure within Sokoto metropolis. The flour and other ingredients needed for the 'biscuit' were purchased as well from Sokoto central market which is located on Latitude. 13º 3'41. 678" N and Longitude. 5º 13'33. 783" E. (GIS Lab UDUSOK)

Sample preparation

The fish was humanely killed, de-gutted and thoroughly washed with clean water to remove blood stain and dirt, drain and then oven dry for. The prepared fresh fish samples of the less valued fishwere tagged, weighed, and arranged in an oven dryer; the drying was done at 60ºC -70ºC temperature for 6-12 hours following Huda *et al.*(2000).The dried fish samples were weighed again to determine the percentage weight lost and pounded to powder by using pestle and mortar. Fish was further grinded with a grinding machine to a very fine powder particle to allow thorough mixture of flour and other ingredients.

Biscuit preparation

The sample was baked after the grinded fish powder was mixed with flour at the percentage of 0%, 0.5%, 2%, 3.5% and 5% respectively, 0% without DFP, 0.5% inclusion rate of DFP, 2% inclusion rate of DFP, 3.5% inclusion rate of DFP and 5% inclusion rate of DFP. Biscuit was prepared using the method described by Singh *et al*., (2008).

Sensory evaluation

This was undertaken to determine the taste, odor, texture, and color of the samples. Taste panel of ten (10) members was train on scoring of the sample and scores at every one-week interval for the period of 4 weeks. The products were scored on a 5-point hedonic scale questionnaire; 8 – excellent, 6 – good, 4 – fair, 2 – poor and 0 – bad according to Eyo, (2001).

Proximate Analysis

The proximate analysis of the fish samples for moisture, ash and carbohydrate contents were determined following the standard methods of analysis by AOAC (2005). Crude protein, fibre and fat contents were determined using Kjeldahl method (Eyo, 2001). The TVB-N was determined as described by Malle and Poumeyro (1989).

Statistical analysis

The data collected was subjected to statistical analysis using one way analysis of variance (ANOVA), and Duncan's multiple range tests was used for mean separation. The statistical analysis was carried out using IBM SPSS version 23 software.

Results

Proximate composition of the 'Biscuit'

The result in table 1 shows that there was no significance difference (P> 0.05) in moisture content between the treatments, however significant differences (P<0.05) were recorded in CHO., Fibre, Ash, Lipid,and C.P. of the product across the treatments.

Table 1: Proximate composition of Biscuit made from dried fish powder

Parameters			Treatments		
	0% DFP	0.5%DFP	2%DFP	3.5%DFP	5%DFP
Moisture	6.00 ± 0.13^{a}	6.04 ± 0.13^{a}	6.04 ± 0.13^{a}	6.00 ± 0.13^{a}	6.21 ± 0.13^{a}
Ash	1.0 ± 0.15^{a}	1.13 ± 0.15^{ab}	1.48 ± 0.15^{b}	1.17 ± 0.15^{ab}	1.21 ± 0.15^{ab}
Lipid	14.30 ± 0.11^{a}	14.67 ± 0.11^{b}	14.88 ± 0.11^{bc}	15.00 ± 0.11^{c}	16.30 ± 0.11^{d}
C.P.	5.66 ± 0.02^{a}	6.10 ± 0.02^{b}	5.86 ± 002^{c}	6.03 ± 0.02^{d}	6.45 ± 0.02^{e}
CHO	72.42 ± 0.33^{c}	71.32 ± 0.33^{b}	70.79 ± 0.33^{b}	70.55 ± 0.33^{b}	69.25 ± 0.33^{a}
Fibre	0.63 ± 0.06^{a}	0.71 ± 0.06^{a}	0.96 ± 0.06^{b}	1.13 ± 0.06^{b}	1.13 ± 0.06^{b}

Sensory evaluation of the biscuit

The result obtained in table shows that there was no significant difference (P>0.05) in all the inclusion rate of dried fish powder across all the parameters.

Table 2: Sensory parameters of Biscuit made from dried fish powder

Parameters			Treatments		
	0% DPP	0.5%DFP	2%DFP	3.5%DFP	5%DFP
Taste	7.20 ± 0.17^{a}	6.85 ± 0.17^{a}	7.10 ± 0.17^{a}	7.25 ± 0.17^{a}	7.05 ± 0.17^{a}
Odor	6.85 ± 0.18^{a}	6.60 ± 0.18^{a}	6.95 ± 0.18^{a}	7.10 ± 0.18^{a}	7.00 ± 0.1^{a}
Texture	6.80 ± 0.18^{a}	6.75 ± 0.18^{a}	6.65 ± 0.18^{a}	7.05 ± 0.18^{a}	6.65 ± 0.18^{a}
appearance	6.85 ± 0.19^{a}	6.95 ± 0.19^{a}	6.95 ± 0.19^{a}	6.95 ± 0.19^{a}	6.75 ± 0.19^{a}

Storage period of Biscuit made from dried fish powder

The result in shows that there was no significance difference (P>0.05) in Day 0 across all the sensory parameters examined. However, significance difference (P<0.05) was recorded in Day

14th, 28th, and 42ndacross all parameters.

Table 3:Effect of storage period on sensory properties of Biscuit made from dried fish powder

Parameters	Storage period			
	0 day	14thday	28thday	42nd day
Taste	6.92 ± 0.15^{a}	6.96 ± 0.15^{a}	7.08 ± 0.15^{ab}	7.40 ± 0.15^{b}
Odor	6.36 ± 0.16^{a}	7.00 ± 0.16^{b}	7.12 ± 0.16^{b}	7.12 ± 0.16^{b}
Texture	$6.\ 48 \pm 0.16^{a}$	6.80 ± 0.16^{ab}	7.00 ± 0.16^{ab}	6.84 ± 0.16^{b}
Appearance	6.60 ± 0.17^{a}	7.04 ± 0.17^{a}	6.84 ± 0.17^{a}	7.08 ± 0.17^{a}

Discussion

The result obtained for proximate analysis of the crude protein was recorded that there was significance difference ($P<0.05$) within the storage periods. Proteins are made up of amino acids; they are required for the synthesis of body protein and other critical nitrogen-containing compounds (Roth, 2011). The crude protein of biscuits samples in this experiment ranged from 5.66% to 6.45%. The lowest crude protein (5.66%) value was obtained in 0% DFP while the highest (6.45%) was obtained in 5% DFP. The biscuits from the different inclusion rate of dried fish powder varied significantly ($P<0.05$) in their crude protein contents which is also comparable to the finding of Norhayati*et al.* (2015) for commercial biscuits sold in Malaysia which ranged from 6.16% to 9.92%. The lipid sample in this experiment ranged from 14.30% to 16.30%. There was significant difference ($P < 0.05$) in the lipid content of the fish biscuit. The ash content increases from 1.0% to 1.21%, this is in line with the observation of Baljeet*et al.* (2014) on the incorporation of carrot pomace powder and germinated chickpea flour into biscuit (0.8-1.2%).

The organoleptic properties of the Biscuit producedshowed that the products were acceptable although the samples with the inclusion rate of 2% and 3.5% have more acceptability. However, there was no significant difference ($P<0.05$) between the treatments. Sensory evaluation of the Biscuit product revealed that as the inclusion rate of dried fish powder exceed 3.5%, the product tends to be less appreciable. Ibitoye*et al.* (2005) reported that 10% inclusion rate of FPC was ‘like much’ by the panel of judges; this may be due to the moderate proportion of the protein content which also appeal to the taste bud.The packaging and storage medium of the product improved the shelf-life during storage. By blocking most oxygen from the outside, bacterial activities can be dramatically decreased so that the shelf-life of the product is extended

(Adam & Moss, 2000; Sharma & Whiting, 2005).

Conclusion

The present study provides information about the suitability of 'Biscuit' produced with wheat flour and some less valued dried fish powder. Inclusion of fish in flour produces a very stable and safe product with long storage life. By assessing the shelf-life quality as well as the feasibility of the processing method, it is revealed that flour treated with fish will contribute to nutritional balance of people consuming snacks in Nigeria. It can be concluded that the fish 'Biscuit' was highly accepted by consumer immediately after processing. Although, all the treatments were accepted by the consumers, but treatment III and IV were mostly preferred. The inclusion of fish in wheat flour before processing has beneficial effects on the overall quality of the final products. This will not only reduce the substantial losses associated with catches but would also increase the nutritional intake of the consumers by substantially improving fish protein intake in Nigeria and reduce protein malnutrition and its associated problems in the country.

References

Abou-Zaid, A. and Elbandy, M. (2014). Production and quality evaluation of nutritious high-quality biscuits and potato puree tablets supplemented with crayfish *Procombarus clarkia* protein products. *J. Appl. Sci. Res*. 10(7): 43–53.

Adam, M.R. and Moss, M.O. (2000). Bacterial agents of foodborne illness. In *Food Microbiology. Second edition.* 200-211.

AOAC, (2003). Official Methods of Analysis of the Association of Official Analytical Chemists, 17th edition. Association of Official Analytical Chemists, Arlington Virginia.

Ayo, J.A. and T. Gaffa, (2002). Effects of undefattedsoyabean flour on the protein content and sensory quality of KunnuZaki. Niger. *Food J*., 20: 7-9.

Baljeet S.Y., Ritika B.Y. and Reena K. (2014). Effect of incorporation of carrot pomace powder and germinated chickpea flour on the quality characteristics of biscuits. *International Food Research Journal*, 21 (1): 217-221.

Bristone, C., Charles, A., and Idakwo, P. (2017). Development of Nigerian based food like biscuit (Guliguli) from mixtures of sorghum, maize, soyabean, moringa leaves, and crayfish. *Int. J. Curr. Res*. 9(10): 59664–59671. ISSN:0975-833X.

Eyo, A.A. (2001). Fish Processing Technology in the Tropics *National Institute for Fres hwater FisheriesResearch*(NIFFR), New Bussa, Nigeria 2nd Edition.

FAO (2003). *FAO Yearbook, Fishery and Aquaculture Statistics*. Rome: Agriculture Organization of the United Nations.

FAO. (2014). Fisheries statistics, Food and Agriculture Organization, Rome, Italy.

Federal Department of Fisheries (1997). *Fishery Statistics Federal Department of Fisheries, Nigeria, Abuja.*

Huda, N., Abdullah, A. and Salam, Babji, A. (2000). Nutritional quality of surimi powder from threadfin bream, *Journal of Muscle Foods*, 11: 99-109.

Ibitoye A., Omojowo,F.S., Adebayo,M.B, Ugwu,F.C. (2005).Development of fish products from smack and underutilized Tilapia (*Oreochromisniloticus*) in Kainji lake area. National Institute of Freshwater Fisheries Research, P.M.B.6006, NewBussa, Niger state.

Mamman, A.B., Oyenbanji, J.O. and Peter, S.W. (2000). *Nigeria: a purple united, a future assumed- Survey of states.* Federal Ministry of Information, Abuja, Millennium edition.

Norhayati, M. K., MohdFairulnizal, M. N., Zaiton, A., Wan Syuriahti, W.Z., Rusidah, S. A. R., Aswir, A. R., Ang,

M. N. M., Naeem, J. L., Suraiami, M., MohdAzerulazree, J., &Vimala, B. (2015). Nutritional composition of selected commercial biscuits in Malaysia. *SainsMalaysiana*, *44*(4), 581–591.

Ohen, S. B., &Abang, S. O. (2007). Economics of catfish farming in Rivers State, Nigeria. *Academic Journal of Plant Sciences*, *2*(1), 56–59.

Olaoye, O.A., A.A. Onilude and C.O. Oladoye, (2007). Breadfruit flour in biscuit making. *Afr. J. Food Sci.*: 20-23.

Roth, R. A. (2011). *Nutrition & Diet Therapy* (10th ed., pp. 111–120). Delmar 5 Maxwell Drive Clifton Park, NY 12065–2919 USA: Cengage Learning.

Sharma, S. K. and Whiting, R. C. (2005). Methods for detection of *Clostridium botulinum* toxin in foods. *Journal of Food Protection, 68,* 1256-1263.

Singh, S., Riar, C.S. and Saxena, D.C. (2008). Effect of incorporating sweet potato flour to wheat flour on the quality characteristics of cookies. *Africa Journal of Fisheries Society*. 2: 065-072.

Subhendu, D.(2013). Value added fish products.https://www.researchgate.net/publication/259345026

73 PROXIMATE AND SENSORY ASSESSMENT OF AADUN PRODUCED FROM MAIZE AND GROUNDNUT PASTE

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ABSTRACT

The effect of partially substituting roasted whole maize (Zea may) flour with groundnut (Arachis hypogaea) paste in the production of aadun and its acceptability was investigated. Formulations of aadun from different combination levels of maize flour (60 - 78%), groundnut paste (5 - 20%) and palm oil (10 - 20%) were generated using a constrained D-optimal mixture-process experimental design while salt and pepper remained constant at 0.5% and 1.5% respectively. Maize-based snack, aadun was produced from the resulting composite blends. Proximate and sensory properties of the samples were determined using standard procedures. Results obtained showed a considerable significant increase ($P \geq 0.05$) in the amount of protein with increase in the level of substitution with groundnut paste, ranging respectively from 6.71 to 16.81%. While similar trends were observed concerning the fat contents, the levels of ash, and crude fibre while carbohydrates and calories showed a significant ($P \geq 0.05$) decrease.

Keywords: *Aadun*, Maize, Groundnut, Snacks, Proximate

INTRODUCTION

Aadun is an indigenous staple food commonly consumed by the Yoruba ethnic group of south-western Nigeria, it is usually reddish and often moulded into balls. It is a snack food prepared from dried maize grain which constitutes nearly 80% of the entire snack (Jonathan *et al.*, 2015). It is characterized by its fine texture, ease of digestion and sweetness and is traditionally served during ceremonial events such as marriage and naming ceremonies and had found acceptability in the past by warriors, women, children and people of all ages (Adedokun, 2006). According to Adedokun (2006), *aadun* is an excellent source of energy with phosphorus and magnesium being its chief mineral but low in crude protein.

It is necessary to improve the nutritional quality and flavour of *aadun* and develop a single product which will have an improved nutritional content and also the flavour which ordinarily would have been obtained from the consumption of two different food items. The objective of this study is therefore to produce nutritionally enhanced *aadun* from maize and groundnut paste and to assess the effects of groundnut paste inclusion on the nutrient and acceptability of *aadun*.

MATERIALS AND METHODS

Materials

Samples of freshly harvested white maize-TZL Comp 4C2 (commonly used by indigenous manufacturers) and unshelled groundnut seed, palm oil, pepper and salt were obtained from *Kasuwa Gwari* (a local market) in Minna, Niger State, Nigeria. The control was produced according to Adedokun (2006).

Production of *Aadun* Snacks

The laboratory-prepared *aadun* was produced using the method of Adedokun (2006). Maize grains were first cleaned, roasted with the aid of an electric hot plate for fifteen minutes and milled. The maize powder and milled pepper were mixed thoroughly and the mixture was later sieved (<0.4mm) to obtain a fine powder. The sieved powdered mixture was later mixed with palm oil and salt to make a paste. The paste was moulded into balls.

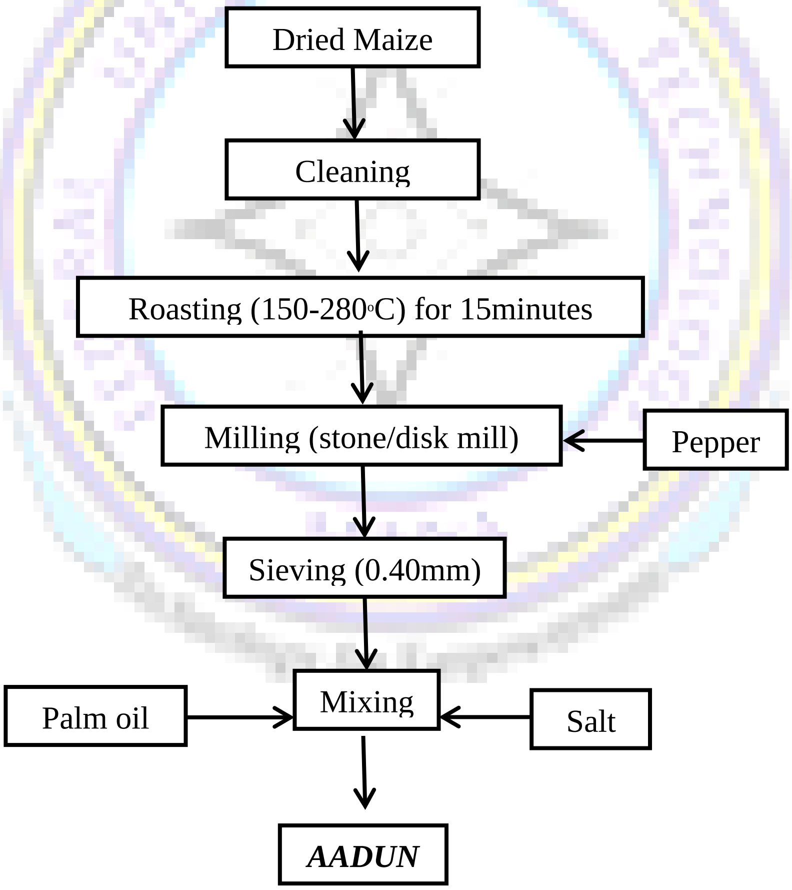

Figure 3: Flow chart for the production of indigenous *aadun* (Adedokun, 2006).

Formulation of *Aadun* supplemented with Groundnut Paste

Formulations of *aadun* from different combination levels of maize flour (60 - 78%), groundnut paste (5 - 20%) and palm oil (10 - 20%) were generated using a constrained D-optimal mixture-process experimental design of Design Expert (version 11, Stat - Ease Inc., USA) while salt and pepper remained constant at 0.5% and 1.5% respectively. There were seventeen runs (treatments) in all with the control (78% maize, 20% oil, 1.57% pepper and 0.34% salt).

Proximate analysis

The proximate composition of the samples was assessed using Association of Analytical Chemists, AOAC (2005) procedures. Moisture content, ash, fibre, fat, protein and carbohydrate were all determined. The Atwater component was used to determine the energy content.

Sensory evaluation

A twenty-man panellist comprising of staff and students of the Federal University of Technology, Minna, Niger State was used for the sensory evaluation and selection was made based on their familiarity with "*aadun*". The samples were presented to the panellists in a randomised order and were evaluated for appearance, taste, aroma, texture and overall acceptability using a 9-point hedonic scale.

Statistical analysis

Data was generated in triplicate and analysis was done using one-way Analysis of Variance (ANOVA) of the Statistical Package for Social Sciences (SPSS version 20.0 for windows) and the means were separated using Duncan's Multiple Range test.

RESULTS AND DISCUSSION

Table 1 and 2 show the results of the proximate composition and sensory evaluation of the *aadun* samples.

Table 1: Proximate composition of the *aadun* samples.

Runs	Moisture	Protein	Fibre	Ash	Fat	CHO	Energy(K/ca)
Control	5.28±0.20^{b}	6.71±0.28^{a}	2.83±0.12^{a}	2.29±0.10^{a}	17.85±0.19^{h}	65.04±0.34^{f}	447.65±1.63^{g}
1	9.12±0.20^{ef}	7.33±0.12^{b}	3.31±0.20^{b}	2.81±0.08^{b}	14.32±0.15^{g}	63.11±0.5^{e}	410.64±1.87^{d}
2	3.50±0.39^{a}	16.81±0.19^{i}	6.06±0.12^{h}	4.45±0.13^{gh}	18.01±0.32^{h}	51.17±1.07^{b}	434.01±1.50^{f}
3	6.32±0.25^{c}	8.73±0.19^{c}	3.69±0.08^{c}	2.91±0.16^{b}	11.21±0.40^{c}	67.14±0.94^{g}	404.37±1.93^{c}
4	5.59±0.38^{b}	14.72±0.16^{h}	5.93±0.13^{h}	4.27±0.17^{fg}	23.50±0.22^{i}	45.99±1.01^{a}	454.34±1.95^{h}
5	8.15±0.38^{d}	13.51±0.21^{f}	5.51±0.14^{g}	4.05±0.10^{ef}	13.75±0.15^{f}	55.03±0.53^{c}	397.91±2.91^{b}
6	5.53±0.16^{b}	14.98±0.28^{h}	5.42±0.10^{g}	4.62±0.14^{h}	18.22±0.15^{h}	51.23±0.26^{b}	428.82±1.48^{e}
7	7.98±0.23^{d}	9.25±0.22^{d}	3.02±0.11^{a}	2.73±0.21^{b}	11.78±0.16^{d}	65.24±0.37^{f}	403.98±0.33^{c}
8	9.14±0.26^{ef}	13.71±0.31^{f}	4.25±0.13^{e}	3.87±0.11^{e}	13.24±0.20^{e}	55.79±0.86^{c}	397.16±0.77^{b}
9	5.53±0.16^{b}	14.98±0.28^{h}	5.42±0.10^{g}	4.62±0.14^{h}	18.22±0.15^{h}	51.23±0.26^{b}	428.82±1.48^{e}
10	10.52±0.11^{g}	8.40±0.12^{c}	3.84±0.15^{cd}	3.22±0.19^{c}	10.34±0.18^{a}	63.68±0.26^{e}	381.38±2.07^{a}
11	9.12±0.20^{ef}	7.33±0.12^{b}	3.31±0.20^{b}	2.81±0.08^{b}	14.32±0.15^{g}	63.11±0.58^{e}	410.64±1.87^{d}
12	9.03±0.19^{e}	10.09±0.17^{e}	4.04±0.17^{de}	3.85±0.12^{e}	14.50±0.16^{g}	58.49±0.54^{d}	404.82±0.36^{c}
13	10.52±0.11^{g}	8.40±0.12^{c}	3.84±0.15^{cd}	3.22±0.19^{c}	10.34±0.18^{a}	63.68±0.26^{e}	381.38±2.07^{a}
14	9.56±0.16^{f}	14.05±0.14^{g}	4.52±0.16^{f}	3.54±0.12^{d}	10.86±0.21^{b}	57.47±0.41^{d}	383.82±1.54^{a}
15	5.59±0.38^{b}	14.72±0.16^{h}	5.93±0.13^{h}	4.27±0.17^{fg}	23.50±0.22^{i}	45.99±1.01^{a}	454.34±1.95^{h}
16	7.98±0.23^{d}	9.25±0.22^{d}	3.02±0.11^{a}	2.73±0.21^{b}	11.78±0.16^{d}	65.24±0.37^{f}	403.98±0.33^{c}

* Values represent mean ± standard error of triplicate determinations and values with same superscript along same column are not significantly different (P≥0.05).

Moisture content, which is one of the remarkable qualities and a commonly used factor in the processing and testing of food qualities was seen to range from 3.04% - 11.32% in the supplemented samples compared to the control (5.28%). High moisture content may affect the storability and the quality of the product. The moisture content obtained was within the range indicated by Idowu *et al*. (2012) who reported that street *aadun* contains 2.42 to 10.59% moisture. The protein content of the snacks significantly (P≥0.05) increased from 6.71% - 16.81% with an increase in the percentage of groundnut paste. Ibitoye *et al*. (2020) also recorded an increase in protein content (5.71% - 6.16%) by supplementing *aadun* with plantain. A similar pattern was noticed by Otunola *et al*. (2012) who indicated a substantial increase in the level of protein from 12.33% - 23.77% after supplementing *Kokoro* with defatted groundnut paste.

The values of fibre (3.02% - 6.06%) and ash content (2.81-4.62) in samples of *Aadun* supplemented with the various constituent of groundnut paste were higher than the values of the control sample 2.83 for fibre and 2.29 for ash content. The reports of Akinola and Enujiugha (2017) were lower values (1.85% - 2.44%) for ash and 2.12 - 2.42% for fibre content after supplementing *aadun* with defatted African oil bean seed flour. The higher ash content of the *aadun* supplemented with groundnut indicates that there may be more minerals present in the supplemented *aadun* than in the plain (control).

The fat ranged from 10.86% - 23.50%. The level of fat in the *aadun* samples may be linked to the palm oil as well as the oil from the groundnut used in the production of the products. The higher fat observed in some of the samples of the supplemented *aadun* may be due to the ability of the maize flour to absorb more oil due to its dryness. Idowu and Adedokun (2011) and Idowu *et al*. (2012) reported higher ranges (30.06% - 52.54%) and (24.87% - 46.11%) after collecting samples from different locations.

The carbohydrate values (45.99% - 67.14%) obtained in this work were greatly higher than the values of 26.18-36.32% reported by Adepoju *et al*. (2020). The energy content of the samples (381.38 - 454.34 kcal/100g) is lower than the values (447.05 - 556.90 kcal/100g) obtained by Idowu *et al*. (2012). The reduction in the calorie content of the supplemented samples may be attributed to the reduction in the added palm oil and carbohydrate content.

Table 2: Sensory evaluation of the sample

Runs	Appearance	Taste	Texture	Aroma	Overall Acceptability
CONTROL	7.70 ± 0.92^{b}	5.90 ± 1.02^{a}	6.05 ± 0.89^{a}	5.85 ± 0.93^{a}	6.15 ± 0.75^{a}
1	7.35 ± 0.93^{ab}	6.05 ± 0.88^{a}	6.10 ± 0.72^{a}	6.10 ± 0.79^{ab}	6.30 ± 0.80^{ab}
2	7.15 ± 0.93^{ab}	7.50 ± 0.61^{cd}	7.35 ± 0.88^{bc}	7.45 ± 0.76^{d}	7.40 ± 0.50^{efg}
3	7.05 ± 0.76^{ab}	6.35 ± 0.67^{a}	6.20 ± 0.77^{a}	6.15 ± 0.81^{ab}	6.50 ± 0.69^{abc}
4	6.90 ± 0.97^{ab}	6.95 ± 0.89^{bc}	7.05 ± 0.83^{b}	7.25 ± 0.91^{cd}	7.35 ± 0.81^{efg}
5	6.75 ± 1.07^{a}	7.00 ± 0.86^{bc}	7.80 ± 0.77^{c}	7.10 ± 0.85^{cd}	7.80 ± 0.70^{g}
6	7.00 ± 1.17^{ab}	7.60 ± 1.00^{d}	7.70 ± 0.87^{c}	7.20 ± 0.83^{cd}	7.30 ± 0.87^{defg}
7	6.95 ± 1.23^{ab}	6.25 ± 0.72^{a}	6.25 ± 0.72^{a}	6.00 ± 0.86^{a}	6.30 ± 0.73^{ab}
8	6.75 ± 1.16^{a}	7.20 ± 0.89^{cd}	7.50 ± 0.89^{bc}	6.95 ± 0.76^{cd}	7.50 ± 0.51^{fg}
9	7.00 ± 1.17^{ab}	7.60 ± 1.00^{d}	7.70 ± 0.87^{c}	7.20 ± 0.83^{cd}	7.30 ± 0.86^{defg}
10	7.30 ± 1.03^{ab}	6.50 ± 0.83^{ab}	6.25 ± 0.79^{a}	6.65 ± 0.88^{bc}	6.90 ± 0.72^{cde}
11	7.35 ± 0.93^{ab}	6.05 ± 0.89^{a}	6.10 ± 0.72^{a}	6.10 ± 0.79^{ab}	6.30 ± 0.80^{ab}
12	7.25 ± 1.25^{ab}	6.20 ± 0.70^{a}	6.15 ± 0.75^{a}	6.80 ± 0.77^{c}	6.80 ± 0.62^{bcd}
13	7.30 ± 1.03^{ab}	6.50 ± 0.83^{ab}	6.25 ± 0.79^{a}	6.65 ± 0.88^{bc}	6.90 ± 0.72^{cde}
14	7.10 ± 0.97^{ab}	7.45 ± 0.69^{cd}	7.35 ± 0.67^{bc}	7.00 ± 0.73^{cd}	7.00 ± 0.80^{cdef}
15	6.90 ± 0.97^{ab}	6.95 ± 0.89^{bc}	7.05 ± 0.83^{b}	7.25 ± 0.91^{cd}	7.35 ± 0.81^{efg}
16	6.95 ± 1.23^{ab}	6.25 ± 0.72^{a}	6.25 ± 0.72^{a}	6.00 ± 0.86^{a}	6.30 ± 0.80^{ab}

* Values represent mean ± standard error of triplicate determinations and values with same superscript along same column are not significantly different ($P\geq0.05$).

The appearance varies significantly ($p\geq0.05$), and ratings ranged from 6.75% - 7.70%. The control (78% maize: 20% palm oil) had the highest rating of 7.70 while run 5 (68.75% maize: groundnut 16.50%: 12.75% palm oil) and run 8 (73% maize: 15% groundnut paste: 10% palm oil) has the least appearance rating of 6.75. The oil produced by the groundnut paste is responsible for the variation in appearance. The taste, texture, aroma and overall acceptability of the supplemented *aadun* were scored higher than the control sample. The rating increased with an increase in the substitution of groundnut paste. Runs 6 and 9 (68% maize: groundnut 20%: 10% palm oil) have the highest rating for taste and run 2 (64% maize: 20% groundnut paste: 14% palm oil) obtained the highest score for aroma, while run 5 for texture and overall acceptability. Snacks containing roasted groundnuts have high consumer acceptance due to their unique roasted groundnut flavour (Eke-Ejiofor *et al*., 2012).

CONCLUSION

Based on the findings of this study, it can be concluded that groundnut paste can be used to supplement maize flour. The proximate analysis conducted on the different samples reveals an increase in the quality of the nutrients with increasing groundnut paste compared to the plain *aadun* (control). The supplemented samples were acceptable to the panellists. However, the most acceptable sample based on the overall acceptability score was run 5 (68.75% maize: groundnut 16.50%: 12.75% palm oil). Supplementing maize in the production of *aadun* with groundnut paste will therefore increase the snack nutrients and acceptability.

REFERENCES

Adedokun, S.O. (2006). Effect of packaging material and storage condition on quality attributes of “*Aadun*” (A maize-based Nigerian snack). M.Sc. Dissertation, Department of Food Science and Technology, University of Agriculture, Abeokuta.

Adepoju, O. T, Dawodu, O. A. and Bamigboye, A.Y. (2020). Nutritional, Sensory and Anti-Nutritional Properties of *Aadun* Enriched with Groundnut and Crayfish. *Advances in Nutrition and Food Science*, 2020(5):1 – 10.

Akinola, S.A. and Enujiugha, V.N. (2017). Physicochemical and Sensory Qualities of “*Aadun*” a Maize-based Snack Supplemented with Defatted African Oil Bean Seed Flour. *Applied Tropical Agriculture*, 22(2):188-196.

AOAC (2005). Official methods of analysis, 18th edition. Association of Official Analytical Chemists, Gaithersburg, MD.

Eke-Ejiofor J., Klin-Kabari D.B. and Chukwu, E.C. (2012). Effect of processing methods on the proximate, mineral and fungi properties of groundnuts (*Arachis Hypogaea*). *Seed Journal of Agricultural and Biological Science,* 3(1): 257-261.

Ibitoye, F.O., Elehinafe, T. R., Komolafe, O.Y. and Osaloni, A.R. (2020). Chemical and Microbiological Assessment of *Aadun* Produced from Varying Proportions of Maize and Plantain Blends. *Asian Journal of Chemical Sciences* 8(3): 52-59.

Idowu, M.A. and Adedokun, S.O. (2011). Process technology, chemical composition and sensory quality of "*aadun*" a maize-based Nigerian snack. *Journal of Natural Sciences Engineering and Technology*, 10(1): 41-48

Idowu, M.A., Atolagbe, Y.M., Henshaw, F.O., Akpan, I., and Oduse, K. (2012). Quality assessment and safety of street vended “*aadun”* (a maize-based indigenous snack) from selected states in Nigeria. *African Journal of Food Science*. Vol. 6(19) pp. 474-482, Doi: 10.5897/AJFS12.056.

Jonathan, S.G., Adeniyi, M.A. and Asemoloye, M.D. (2015). Nutritional value, Fungi bio-deterioration and Aflatoxin contaminations of Maize Snack (*aadun*). *Researcher Journal*, 7(12); 26-31. (ISSN: 1553-9865).

74 NUTRI-CEREALS AS POTENTIAL FUNCTIONAL INGREDIENTS: CHARACTERIZATION AND VALORIZATION

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Abstract

Nutri-cereals is the term coined by Government of India in 2018 during "National Year of Millets" to popularize ten potential cereal grains owing to their agrarian and nutritonal potential. Nutri-cereals are potential candidates to overcome world hunger and malnutrition because of their favourable growing conditions and balanced profile of macro and micronutrients. Millets are rich source of all nutrients and bio-functional constituents containing 60-70% carbohydrates, 7-11% protein, 2-7% dietary fibre, 1.5-5% fat with significant amount of vitamins, minerals and approximately all essential amino acids. Dietary quality is the major factor in dealing with malnutrition and food security. Nutritional security is a crucial factor for health and development sustaining genetic potential of every individual. Sorghum and millets-based products have been a part of diet of many rural communities across India, Africa and Eastern Europe. Several traditional products from millets are getting extinct due to 'nutrition transition'. Urbanisation and economic stability in areas where the staple diet was millets have caused paradigm variation in dietary pattern resulting in consumption of modern-day western foods and beverages. Another factor for escape of nutri-cereals from regular diet was lack of optimum processing conditions. Present day, significant investment in terms of funding and time has been dedicated to these grains for optimization of processing techniques and valorization. Researchers have now recommended that nutri-cereals are potential candidates for value added products to overcome food and nutritional security.

Keywords: Millets, bioactive compounds, functional properties, nutritional security

75 MICROBIOLOGICAL QUALITY OF DEVELOPED WHEAT BISCUIT FORTIFIED WITH EGGSHELL CALCIUM

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Abstract

Eggshell powder supplementation has been studied to have a beneficial effect in the dietary pattern of eggshell utilization. Supplementation of biscuit with eggshell powder provides a relatively simple and cheap way of providing calcium and other minerals to a vast number of people who consume it. Fortification of biscuit with eggshell calcium was done by replacing wheat flour with eggshell powder (WE) in replacement ratios of (WE1)100:0 (control), (WE2) 95:5, (WE3) 90:10, (WE4) 85:15, (WE5) 80:20, (WE6) 75:25. Microbiological quality of the biscuit samples was examined by determining the total plate count for bacterial and fungal count. Bacterial count was found to be 1.64×10^{6} in sample WE4 (85:15) and 4.1×10^{6} in sample WE2 (95:5) and the same trend was seen in the fungal count. The variations in the count numbers within the replacement ratios revealed that the microbial presence had no relationship with the incorporation of eggshell powder.

Keywords: Eggshell, Calcium, Biscuit, Microbiological quality, Fortification

Introduction

Wheat flour is usually used to achieve calcium fortification. It is also a staple food for many people and therefore, enriching wheat flour provides a low-cost and simple way to provide micronutrients to a large number of people who need them.

Calcium is required by the body for a range of physiological activities as well as the long-term maintenance of bone and tissue. According to Brun *et al*. (2013), a proper calcium intake between childhood and puberty is important in achieving a heritably determined ideal bone mass at a young age, which influences the risk of osteoporosis later in life.

Chicken eggshell is chemically comprised of water (2%), solid material (98%), protein (5%) and ash (93%). Apart from calcium, it also provides small quantity of other mineral elements including iron, zinc, magnesium, copper, manganese, sulfur, silicon (Ali *et al*., 2019). Eggshell can be utilized as a source of calcium in preventing calcium deficiency in the body while also minimizing environmental pollution. The best natural supply of calcium is eggshell calcium, which has been shown to be highly absorbable (Bee, 2011). Eggshell membrane contains glycosaminoglycan, a required protein that occurs naturally to maintain joint and connective tissue health, and that it was safe for human intake at levels exceeding 500mg per day. King O'ri, (2011). A medium-sized egg produces around one teaspoon of eggshell powder, which is approximately 750-800 mg of elemental calcium with other microelements including amino acids, iron and phosphorus. The utilization of eggshells, poses microbial contamination risk, hence the purpose of this research study.

Materials and Methods

The wheat flour, sugar, fat, salt and baking powder used for the production of the biscuits, were bought from Minna Central Market, Niger State - Nigeria. Eggshells were sourced from local tea shops, located around the hostel area at the permanent site of the Federal University of Technology Minna, Niger State - Nigeria.

Eggshell Powder Preparation

Eggshell powder was prepared following the method given by Ray *et al*. (2017) with slight modifications. The shell membrane was removed from the eggshells after they were washed twice in warm water. To kill hazardous germs, eggshells were boiled in water for 45 minutes and then dried in an oven at 80°C for two hours. the dry eggshells were broken into small pieces, pounded with a motar and pestle to reduce size. Using a sterilized kitchen miller, the powdered eggshells was then milled with into a fine powder. The powder was filtered through a sterilized 50-mesh screen, and the fine powdered eggshells were collected and stored in airtight Ziploc bags and kept in a dry place until needed.

Biscuit preparation

The biscuit was prepared using the method described by Lalmuanpuia, *et al*. (2017) with some modifications. The ingredients were weighed, after which the dry ingredients were mixed in varying rate of Eggshell powder in mixing dish. The liquid ingredients were added and mixed to form a mass (dough). Hand rubbing was done to get homogenous mixture (Kneading). The dough was left to rest for 15 minutes, which was followed by cutting and sheeting of the dough into desired thickness. Baking was done at 200^{o}C for 15-20 minutes.

Microbial evaluation of the biscuits

Microbial analysis for the samples was carried out using the method of Okojoh (2006) for microbial analysis, which involved preparation of media, serial dilution, inoculation, incubation, gram stain for total plate count, pure isolation and biochemical test. The nutrient agar culture plate was cultured for 24 hours at 37°C. The MacConkey agar was cultured at 37°C for 24 hours. The colonies formed by the cultures were quantified in colony forming units per gram (CFU/g).

Pure isolation and biochemical tests

Distinct colonies were picked from the mixed cultured plates and separately streaked in quadrant streak-plate method to obtain pure culture isolates. The streaked plates were incubated at 37℃ for 24 hours for bacterial growth. This process was repeated until pure cultures were obtained. In obtaining pure cultures, PDA and NA were prepared in McCartney bottles and sterilized in an autoclave. The media were allowed to set in an incline position to make agar slants. The pure bacterial isolates were transferred into sterilised NA slant and incubated at 37°C. Biochemical test which included Gram stain reaction, catalase, coagulase test, citrase utilization test, and oxidase test was carried out for identification of the organisms after stock isolation.

Results and Discussion

Microbial quality evaluation of biscuit samples

Table 1: Total plate count of biscuit

TPC	WE1	WE2	WE3	WE4	WE5	WE6
Cfu/g Bacteria	2.01×10^6	4.1×10^6	2.64×10^6	1.64×10^6	2.09×10^6	1.78×10^6
Cfu/g Fungal	1.12×10^6	9.3×10^6	1.09×10^6	1.0×10^6	8.0×10^6	1.20×10^6

Key: WE1= 100% wheat flour, WE2: 95% wheat flour and 5% eggshell powder, WE3: 90% wheat flour and 10% eggshell powder, WE4: 85% wheat flour and 15% eggshell powder, WE5: 80% wheat flour and 20% eggshell powder, WE6: 75% wheat flour and 25% eggshell powder. TPC=Total plate count.

The total bacterial count presented in Table 1, was lowest in sample WE4 (85:15) 1.60 x 10^6 cfu/g and highest in WE2 (95:5) 4.0 x 10^6 105 cfu/g and the same trend was observed in the fungal count result, the highest count was seen in sample WE2 (95:5) with 9.3×10^6 and the lowest count was seen in sample WE4 (85:15) with 1.0×10^6. The observed results variation in bacterial and fungal counts between the samples in comparison with the increasing levels of eggshell powder replacement showed that the bacterial and fungal contamination were not as a result of the incorporation of the eggshell powder.

Table 2: Characterization of bacteria isolates from biscuit sample

Sample	GR	Shape	CAT	COU	MR	VP	UR	OXI	H_2S	G	L	S	CIT	MSA	IND	Organism isolated
WE1	−	Rod	+	−	−	+	−	+	−	+	+	+	+	−	−	*Psuedomonas aeruginosa*
WE2	+	Rod	+	−	−	+	−	−	−	−	−	+	+	−	−	*Bacillus subtilis*
WE3	−	Rod	−	−	−	+	−	−	−	+	+	+	+	−	−	*Klebsiella sp*
WE4	+	Cocci	+	+	−	−	−	−	−	+	−	+	−	+	−	*Staphylococcus aereus*
WE5	−	Rod	+	+	−	−	−	−	−	+	−	+	−	+	−	*Staphylococcus aereus*
WE6	+	Cocci	+	+	−	−	−	−	−	+	−	+	−	+	−	*Staphylococcus aereus*

(+) = Presence, (−) = Absence GR= Grams reaction; CAT= Catalase test; COU= Coagulase test; CIT= Citrase test; OXI= Oxidase test; VP= Vges Proskauer Test; UR= Urease Test; H_2S = Hydrogen Sulphide Test; G = Glucose Test; MSA = Mannitol Salt Agar Test; IND =Indole Test; S = Sucrose Test; L = Lactose Test

Characterization and probable organisms in the samples

Bacillus substilis was detected in biscuit sample WE4 which had the highest bacteria count. *Bacillus substilis* is present in starchy products, and some species are engaged in fermentation. It also has the ability to generate endospores, which are heat, ultraviolet light, and desiccation resistant, therefore their presence in the samples suggests the existence of heat-resistant microbes (Olunlade *et al.*, 2013). Bacillus species contamination is most commonly caused by a lack of proper time and temperature control during cooling and subsequent storage, allowing spores to germinate and grow. *Pseudomonas aeruginos* was detected in sample WE1 (control) with bacteria count of 2.01×10^{6}. *Pseudomonas aeruginos* are gram negative, aerobic bacteria found in soil and on human skin. It can be introduced into food by human contact and food utensils. *Klebseilla spp* was observed in biscuit sample WE3 (90:10) with bacterial count of $2.64\times10^{6.}$ *Klebseilla spp* is a feacal coliform that is introduced from contaminated water. It possess high resistant cyst, which protects it from extreme heat. In biscuit sample WE4 (85:15), WE5 (75: 25) and WE6 (75: 25), *Staphylococcus aureus* was identified. Food handlers are the main source of food contamination via direct contact especially in extensive handling during preparation. Its contamination can occur via hands or respiratory secretions.

Time and temperature abuse of contaminated can result in growth of Staphylococcus *aureus* and the subsequent production of enterotoxin in the food products. (Food Standards Australia Newzealand, 2016).

Conclusion

The results variation in the total plate count for bacterial and fungal counts within the biscuit samples in comparison with the increasing levels of eggshell replacement shows that the bacterial contamination of the biscuit samples had no relationship with the replacement ratios of eggshell powder. The unacceptable levels of bacteria observed might have resulted from temperature abuse and poor hygienic practices and the use of non-sterile equipment. A five percent (5%) eggshell powder incorporation is recommended for fortification food products

References

Ali, M. and Badawy, W. Z (2017). Utilization of eggshells by-product as a mineral source of fortification of brad strips. *Journal of Food and Diary Sciences,* 8(11), 455-459.

Bee, W., (2011). How to make calcium from egg shells. www.Healing naturally by Bee. Downloaded from the internet on 30/09/2011.

Brun, L.R., M. Lupo., D.A., Delorenzi, V.E. DiLoreto and A. Rigalli., (2013). Chicken eggshell as suitable calcium source at home. *International Journal Food Science and Nutrition*, 64(6): 740.

King'ori, A.M., (2011). A Review of the Uses of Poultry Eggshells and Shell Membrane. *International Journal of Poultry Sciences*, 10(11): 908-912.

Lalmuanpuia, C., Singh, S. S., and Verma,V.K.(2017). Preparation and quality assessment of fortified cookies by using wheat flour, flaxseed flour and carrot pomace. The Pharma Innovation, 6(7, Part D): 246.

Subhajit, R., Amit, K.B., Pradip, K.R and Bipin K.S. (2017) Chicken eggshell powder as dietary calcium store in chocolate cakes. *The Pharma Innovation Journal,* 6(9):01-04.

Ojokoh, A.O. (2006). Microbiological examination of ice cream sold in Akure. *Pak. J. Nutr*., 5(6): 536-538.

Olunlade, B.A., (2013). Microbial profile of maize pigeon pea biscuit in storage. *Fountain Journal of Natural and Applied Sciences*, 2(2).

CROP SCIENCE/PRODUCTION

76 EVALUATION OF SINGLE AND MIXED VIRUS-INOCULATED BAMBARA GROUNDNUT LANDRACES FOR NODULATION AND NITROGEN FIXATION

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ABSTRACT

Bambara groundnut (Vigna subterranea [L.] Verdc) enriches soils by forming a symbiotic relationship with nitrogen-fixing and stem-nodulating bacteria. Virus infections, however, limit the plant's ability to fix nitrogen. The study evaluated the nodulation and nitrogen-fixing ability of Bambara groundnut landraces (Vg 01, Vg 02, Vg 03, Vg 04, and Vg 05) under single and mixed virus infections of Blackeye cowpea mosaic virus (BlCMV; Potyvirus), Cowpea mild mottle virus (CPMMV; Carlavirus), BlCMV+CPMMV, and CPMMV+BlCMV. The experiment was conducted under screenhouse conditions, using a completely randomised design with three replications. The results showed that the landraces varied significantly ($p<0.05$) in their nodulation and symbiotic effectiveness (SE). The highest number of nodules (7 per plant) was observed in Vg_04 followed by Vg_05 (6 per plant), and Vg_01 had the lowest of 5 nodules per plant. The highest reduction in the number of nodules per plant was 54.1 %, dry weight of shoot 48.6 % and root 43.8 %; length of shoot and root reduced by 43.1 % and 59.3 %, respectively in BlCMV+CPMMV treated plants. Nitrogen-fixing efficiency of the landraces varied from ineffective (IE), in BlCMV (SE = 29.1 %) and BlCMV+CPMMV (SE = 32.0 %) to poorly effective (PE) for CPMMV (SE = 35.6 %) and CPMMV+BlCMV (SE = 36.4 %) while the control treatment was effective with average percentage SE of 70.7 %. These results suggest the need to protect plants from virus infections to guarantee desirable yield and food security.

Keywords: Bambara groundnut, Landraces, Nitrogen Fixation, Nodulation, Virus

INTRODUCTION

Bambara groundnut (*Vigna subterranea* (L.) Verdc) is an indigenous legume of Africa; cultivated across the Sub-Saharan and Semi-Arid region of Africa, Southeast Asia in regions of Indonesia and Thailand (Mayes *et al*., 2019). The crop is the third most important food legume in Africa after groundnut and cowpea, both in consumption and land area under cultivation (Puozaa *et al*., 2017). It is a hardy, drought-tolerant legume which thrives well in nutrient deficient soils largely due to its ability to form effective root nodules with compatible soil rhizobia that convert atmospheric nitrogen (N) to Ammonia for bacterial and plant use, thereby contributing to soil fertility (Mbosso *et al*., 2020). However, the ability of a plant to form nodules along with the subsequent capacity of fixing nitrogen (symbiotic effectiveness, SE) could be hampered when infected with a virus, resulting in significant yield reductions. Also, systemic virus infections of grain legumes severely hamper N2 fixation and the effectiveness of the symbiosis by controlling the plant cellular machinery for replication (López *et al*., 2017). Among the viruses infecting Bambara groundnut on the fields in Nigeria *Blackeye Cowpea mosaic virus* (BICMV) *Potyvirus* and *Cowpea mild mottle virus* (CPMMV) *Carlavirus* have emerged in the past two decades as an important threat ravaging the crop. The exploitation of the genetic variation in the available landraces of Bambara groundnut for multiple virus resistance with high nodulation and nitrogen-fixing ability could contribute to the improvement of the crop and selection of elite genotypes against the viruses. Also, the availability of seeds of cultivars with a high level of multiple virus resistance could aid in the effective management of virus diseases. Hence, this study was carried out to determine the effects of single and mixed infections on nodulation and nitrogen fixation in virus-inoculated Bambara groundnut plants.

MATERIALS AND METHODS

Source of experimental materials and virus isolates

The five Bambara groundnut landraces used were obtained from the local farmers in Minna, Niger State and the nitrogen fertilizer was obtained from a reputable Agro-chemical Store in Minna. The isolates of BlCMV and CPMMV were obtained from the stock in the Department of Crop Production, Federal University of Technology (FUT), Minna, maintained and multiplied on cowpea plants (Ife Brown) to ensure sufficient inoculum.

Virus multiplication

Multiplication of the viruses was done with three plastic pots (30 cm diameter and 30 cm deep) at the rate of two seedlings per pot. The collected virus inoculum in the infected leaf tissues was extracted by grinding the isolate in an extraction buffer (pH 7.2) (0.1M sodium phosphate dibasic, 0.1M potassium phosphate monobasic, 0.01M ethylene diamine tetraacetic acid and 0.001M L-cysteine per litre of distilled water) at the rate of 1 g/mL. One microlitre of β-mercaptoethanol was dispensed into the extract just before being used. Before inoculation, the plants were dusted with carborundum powder (600 mesh) to facilitate the entry of the virus into the hosts. Inoculation was done mechanically by using a pestle to rub sap over the upper leaf surface from base to top of the leaf and incubated at screenhouse temperatures of 23 – 32° C.

Experimental site and design

The experiment was conducted under screenhouse conditions at the Teaching and Research Farm

(9.51752o N, 6.4419o E and altitude 203 masl), FUT, Minna. Top loamy soil (0–15 cm) was collected from the Teaching and Research Farm, bulked together and thoroughly mixed to form a composite. A sub-sample (10 g) of the homogeneous composite soil was air-dried and passed through a 2 mm diameter sieve for physical and chemical analysis. Soil analysis was carried out according to the procedures described by Okalebo *et al*. (2002). The set-up for the assessment of nodulation and nitrogen fixation in Bambara groundnut landraces inoculated with the virus treatment combinations consisted of five landraces of Bambara groundnut, two different viruses (BlCMV and CPMMV) in 4 virus treatment combinations and control, 2 Nitrogen levels (starter N and without starter N) with each replicated two times (5 × 5 × 2 × 2) making a total of 100 experimental bags arranged in a completely randomised design (CRD).

Sowing and seedling inoculation

A total of 100 experimental bags (30 cm diameter and 30 cm deep) were filled with 20 kg of soil and labelled properly based on the treatment. Seeds of the landrace were sown in the bags at the rate of three seeds per bag and seedlings thinned to one plant per bag a week after emergence. After thinning of samples, 1.75 g of nitrate fertilizer was applied to the soil of each N starter treatment sample. The seedlings were then mechanically inoculated with respective virus treatment at 2 and 3 weeks after emergence as presented below: i) Single virus inoculation: The landraces were inoculated singly with each virus BICMV and CPMMV; ii) Mixed virus inoculation: For mixed virus treatments a set of the landraces were first pre-inoculated with one of the viruses singly and 7 days later with the second and vice-versa (Nsa and Kareem, 2015). The plants were irrigated daily with 500 mL and observed for symptom development.

Data collection and analysis

At 45 days after inoculation, the plants were carefully uprooted and rinsed under running tap water through a 40-mesh screen to remove all traces of soil. The number of nodules per plant was counted and the dry weight of the root and the shoot were recorded after drying at 70 ºC for 48 hours (Kabede *et al*., 2020). Data collected were subjected to analysis of variance (ANOVA) using the statistical analysis system (SAS, 2008). Symbiotic effectiveness percentage (SE %) was calculated by comparing the inoculated plant with the N-fertilized positive control (Purcino *et al*., 2000). Nitrogen-fixing efficiency (NFE) was classified as highly effective (SE %> 80%), effective (SE % = 50-80%), poorly effective (SE % = 35-50% and ineffective (SE % <35%).

RESULTS

Symptomatically, all the inoculated plants exhibited varying degrees of foliar symptoms of both single and mixed virus infections. The mixed infection had high effects on the morphological indices and nodulation when compared to the single inoculated plant. Significant ($p<0.05$) lowest dry weight of shoot (0.57 g) and root (0.09 g) were obtained in BICMV+CPMMV treated plants with parentage reduction of 48.6 and 43.8, respectively (Table 1). Similarly, the shortest shoot (10.61 cm) and root (6.15 cm) length was recorded in BICMV+CPMMV.

The highest average number of nodules (9 per plant) was obtained in the control plant, followed by 6.2 nodules per plant in CPMMV and the lowest of 4.13 nodules per plant in BICMV+CPMMV. However, the lowest nodules per plant were not significantly different ($p>0.05$) from the values of CPMMV+BICMV (4.8 per plant) and BICMV (4.87 per plant (Table 1). Significant ($p<0.05$) differences were observed among the landraces for all the morphological parameters and number of nodules per plant with Vg_05 having the highest dry weight (0.89 g), length of the shoot (15.25 cm) and root (11.92 cm) while Vg_04 had the highest average number of nodules per plant with the value of 6.93 followed by 6.13 in Vg_05. However, there were no significant differences ($p>0.05$) among Vg_01, Vg_02 and Vg_03 with values of 5, 5.33 and 5.6, respectively (Table 1).

The mean Nitrogen-fixing efficiency varied from ineffective (SE< 35 %) in BICMV and BICMV+CPMMV to poorly effective (SE = 35-50 %) in CPMMV and CPMMV+BICMV (Table 2). *Blackeye cowpea mosaic virus* exhibited considerable deleterious effects on symbiotic activities of Vg_01 (26.05 %) and Vg_02 (25.91 %) while CPMMV had a higher negative effect on Vg_03 and Vg_04 with a percentage symbiotic effectiveness value of 22.13 % and 25.25 %, respectively. Percentage symbiotic effectiveness for BICMV+CPMMV and CPMMV+BICMV infected plants ranged from 24.21 – 43.96 % and 25.10 – 46.48 %, respectively (Table 2). However, the percentage of symbiotic effectiveness of the control plots varied from 56.42 % in Vg_01 (Effective, SE = 50-80 %) to 91.22 in Vg_05 (Highly effective, SE>80 %).

Table 1: Growth indices and nodulation of Bambara groundnut infected with single and mixed *Blackeye cowpea mosaic virus* (BlCMV) and *Cowpea mild mottle virus* (CPMMV)

Factor	Dry Weight				Length				Number of Nodules
	Shoot (g)	% Red	Root (g)	% Red	Shoot (cm)	% Red	Root (cm)	% Red	
Treatment									
BICMV	0.83b	25.2	0.11c	31.3	11.38d	38.9	7.65b	49.3	4.87c
CPMMV	0.62c	44.1	0.15b	06.3	16.97b	09.0	14.63a	03.1	6.20b
BICMV+CPMMV	0.57c	48.6	0.09c	43.8	10.61d	43.1	6.15c	59.3	4.13c
CPMMV+BICMV	0.59c	46.8	0.14b	12.5	12.55c	32.7	8.82b	41.6	4.80c
Control	1.11a	-	0.16a	-	18.64a	-	15.10a	-	9.00a
SEM	0.06		0.01		0.38		0.51		0.36
Landrace									
Vg_01	0.76a		0.16a		13.77bc		7.82c		5.00b
Vg_02	0.55b		0.14ab		14.51ab		11.67a		5.33b
Vg_03	0.68ab		0.13ab		13.84bc		9.73b		5.60b
Vg_04	0.79a		0.09c		12.79c		11.21a		6.93a
Vg_05	0.89a		0.12b		15.25a		11.92a		6.13ab
SEM	0.06		0.01		0.38		0.51		0.36

Means followed by similar alphabet letters are not significantly different by Student-Newman-Keuls (SNK);
% Red = Percentage reduction

Table 2: Symbiotic effectiveness of Bambara groundnut infected with single and mixed *Blackeye cowpea mosaic virus* (BlCMV) and *Cowpea mild mottle virus* (CPMMV)

Treatment	Vg_01	Vg_02	Vg_03	Vg_04	Vg_05	Mean	NFE
BICMV	26.05	25.91	33.02	34.50	26.00	29.10	IE
CPMMV	45.92	36.91	22.13	25.25	47.59	35.56	PE
BICMV+CPMMV	37.68	28.27	43.96	26.07	24.21	32.04	IE
CPMMV+BICMV	45.16	46.48	25.10	25.32	39.88	36.39	PE
Control	56.42	68.23	70.35	67.44	91.22	70.73	E
Mean	42.25	41.16	38.91	35.72	45.78	40.76	

NFE = Nitrogen fixing efficiency, HE = Highly effective, E = Effective, PE = Poorly effective, IE = Ineffective. Highly effective (SE>80 %), Effective (SE= 50-80 %), Poorly effective (SE = 35-50 % and Ineffective (SE<35 %)

DISCUSSION

The expression of typical foliar symptoms of BICMV, CPMMV or both viruses by all the inoculated plants indicated that none of the Bambara groundnut landraces was immune to the disease. The low growth (weight and length of shoot and root) parameters values and the number of nodules recorded in the inoculated plants of this study could be attributed to the proliferation of particles from replicating virus (es), resulting in alteration of growth pathways. In support of this assertion, Salaudeen and Aguguom (2014) reported that a series of physiological changes are triggered as soon as a virus is introduced into a host plant depending largely on the genetic composition of the infected plant. Similar to this result, López *et al*. (2017) who worked on the plants pre-infected with *Southern bean mosaic virus* (SBMV) attributed the greater magnitude of the deleterious effects on growth masses to the virus' presence in the radicles. The authors further ascribed this to the virus hampering the catabolism of ureides in the leaves.

The N2 fixation by bacteroids within the nodules has great importance in agriculture since leguminous crop yields are highly enhanced in Rhizobium-nodulated plants grown in low nutrient soils (Mabrouk and Belhadj, 2016). The ability of a plant to form nodules along with the subsequent capacity to fix nitrogen (symbiotic effectiveness) is widely used as means of evaluating the inherent links between rhizobia and respective hosts (Osei *et al*., 2018). In conformity with the result of this study, a drastic reduction in root nodulation of virus-infected plants had been reported by López *et al*. (2017). The variation in the number of nodules among the landraces indicated that responses to nodule efficiency differed from one landrace to another. The high number of nodules recorded in the control plants as well as Vg_04 and Vg_05 indicated sufficiently establishment of the Rhizobium–host relationship for nodulation. The poor to ineffectiveness in symbiotic activities of all the landraces when inoculated with either or both viruses could be attributed to an alteration in symbiotic signalling molecules.

CONCLUSION

The study confirmed that all tested viruses reduced growth indices and nodulation of the infected plans. It was also found that either BICM and CPMMV or their combination decreased nitrogen fixation with greater deleterious effects exerted by the mixed viruses. Though the landraces showed different symbiotic characteristics, Vg_05 had proven to be more effective among the landraces and could be explored further to determine its potential for crop improvement.

REFERENCES

López, M., Muñoz, N., Lascano, H. R. & Izaguirre-Mayoral, M. L. (2017). The seed-borne Southern bean mosaic virus hinders the early events of nodulation and growth in Rhizobium-inoculated *Phaseolus vulgaris* L. *Functional Plant Biology*, 44, 208–218.

Mabrouk, Y., & Belhadj, O. (2016). Enhancing the biological nitrogen fixation of leguminous crops grown under stressed environments. *African Journal of Biotechnology*, 11, 10809–10815.

Mayes, S., Ho, W.K., Chai, H.H., Gao, X., Kundy, A.C., Kumbirai, I., …. Azam-Ali, S.N. (2019). Bambara groundnut: an exemplar underutilised legume for resilience under climate change. *Planta*, 250, 803 – 820.

Mbosso, C., Boulay, B., Padulosi, S., Meldrum, G., Mohamadou, Y., Niang, A.B., …. & Sidibe, A. (2020). Fonio and Bambara groundnut value chains in Mali: issues, needs, and opportunities for their sustainable promotion. *Sustainability*, 12, 4766.

Nsa, I.Y. & Kareem, K.T. (2015) Additive interactions of unrelated viruses in mixed infections of Cowpea (*Vigna unguiculata* L. Walp). *Frontiers in Plant Science*, 6, 812.

Okalebo, J. R., Gathua, K. W. & Woomer, P. L. (2002). Laboratory Methods of Soil and Plant Analysis: A Working Manual, Moi University. Second Edition, Nairobi, Kenya. pp. 128.

Osei, O., Abaidoo, R.C., Ahiabor, B., Boddey, R.M., & Rouws, L. (2018). Bacteria related to Bradyrhizobium yuanmingense from Ghana are effective groundnut micro-symbionts. *Applied Soil Ecology*, 127, 41–50.

Puozaa, D.K., Jaiswal, S.K. & Dakora, F.D. (2017) African origin of *Bradyrhizobium* populations nodulating Bambara groundnut (*Vigna subterranean* L. Verdc) in Ghanaian and South African soils. *PLoS ONE* 12(9), e0184943.

Purcino, H. M. A., Festin, P. M., & Elkan, G. H. (2000). Identification of effective strains of Bradyrhizobium for *Archis Pintoi*. *Tropical Agriculture*, 77(4), 226–231.

Salaudeen, M. T. & Aguguom, A. (2014). Identification of some cowpea accessions tolerant to *Cowpea mild mottle virus*. *International Journal of Science and Nature*, 5 (2), 261 – 267.

77 EFFECTS OF Jatropha curcas LEAF EXTRACT ON THE GROWTH CHARACTERISTICS AND NEMATODE ASSOCIATED WITH TOMATO (Solanum lycopersicum)

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ABSTRACT

Tomato (Solanum lycopersicumL.) is a good source of income for many farmers in both local and export trade. The experiment was conducted at the screen house of School of Agriculture and Agricultural Technology, Federal University of Technology, Minna. The experiment was to determine the effect of Jatropha curcas leaf extract on nematode associated with tomato. The treatments were 5 concentration levels of 100 %, 50 %, 10 %, 1 % and control, arranged in a completely randomized design (CRD) with four replications. Data were collected on number of leaves, number of fruits, fresh and dry weight and root knot index. Data collected were to Analysis of variance (ANOVA) and means were separated using Duncan Multiple Range Test (DMRT) at 5% level of probability. The results indicated that significant level on number of leaf was observed at 12 WAI at Standard concentration level with 85.88 as compared to control with 50 at 12 WAI. Concentration level Standard (S) recorded the highest number of fruit, fruit weight, fresh weight, dry weight and reduced index of root knot as compared to other concentration levels.

The study revealed that the effectiveness of using different concentration levels of Jatropha curcas leaf extract for the control of Meloidogyne incognita. The Standard solutions (100 %) of Jatropha curcas leaf extract was more effective in the reduction of root knot formation and also enhanced the growth parameters of the tomato thus, provides a promising option for nematode management.

Keywords: *Meloidogyne incognita*, tomato, *Jatropha curcas*, concentration levels

INTRODUCTION

Tomato (*Solanum lycopersicum* L.) is a major vegetable crop for most Nigerians with production estimated at 170 tonnes (FAO, 2011). Tomato has many varieties widely grown in the greenhouses and in cooler climates. It contributes most of the calorie requirements for each day and the fruits are consumed in several forms: raw in salads, soup paste, Unripe green tomatoes can also be blended and fried, used to make salsa or pickled, juice in cocktail (Rao and Balachandran, 2002). Major tomato production is in the forest and the guinea Savanna zones of Nigeria.

Tomato cultivation and storage suffer serious problems and the major constraints to its production as they have direct negative effect on its quality and yield. Therefore, there is need for the knowledge of control measure of nematode attacking tomato in major tomato growing areas. Therefore, this study was set up to facilitate the development of preventive and management measures for tomato production.

Nematodes are the most numerous animals on earth (Kimpinski and Sturz, 2003). Nematodes are obligate plant parasites with smooth, cylindrical, relatively long worms that destroy the plant tissues (Ellis *et al*., 2008). The most important plant parasitic nematodes are root knot nematodes *(Meloidogyne* spp), cysts nematodes (*Heterodera*spp and *Globodera*spp), root lesion nematodes (*Pratylenchus* spp), bulb and stem nematodes (*Ditylenchus dipsaci*), Spiral (*Helicotylenchus* spp), Reniform (*Rotylenchulus reniformis*), Dagger (*Xiphinema* spp), Bud and leaf (*Aphelenchoides* spp) and burrowing nematodes (*Radopholus similis*) (Ellis *et al*., 2008).

In Nigeria, Root Knot Nematodes (*Meloidogyne incognita*), RNK is the most prevalence in the humid forest, reaching an incidence of 73%. The nematode spread through nursery and fields and mostly through infected planting material and their accumulation paralysis tomato variety movement worldwide.

Some of the crops that may be severely damaged by *Meloidogyne incognita* are tomato, pepper, okra, watermelon, cantaloupe, onion, pumpkin, squash, sweet potato, sweet corn, carrot, eggplant, bean and peas (Trudgill and Blok, 2001). Root Knot Nematodes *(Meloidogyne incognita)* are abundant `in the soils of Nigeria, which are very susceptible to food crops causing losses in both quality and quantity. It is an important parasite which causes severe loss in tomato production (Olabiyi *et al*., 2009). Symptoms of tomato infected with root knot nematode are retardation of seedling growth, yellowing of leaves, wilting of plant.

Pollination of *Jatropha* plant is by insect and contains approximately 175 known species (Kumar, *et al*., 2008). *Jatropha curcas* production is gaining more awareness all over the world as a result of several benefits derived from the plant. The current production of *Jatropha* is estimated to 3 tons per ha to 30 tons per ha in Mali given the production rate to be 2,800 kg per ha per annum when harvested (Henning, 2002).

Jatropha curcas leaf extracts kill the larvae of mosquito species that vector infectious diseases such as malaria (Valencia *et al*., 2006). *Jatropha* leaf extracts reduce fungal pathogen growth like brown blotch disease, and *Colletotrichum*s pp in cowpea (Onuh *et al*., 2008). Extract from *Jatropha curcas* leaves exhibit insecticidal activity against a wide range of *Lepidopteran* species (Phowichit *et al*., 2008). *Jatropha* seeds extract are reported to cause 97-100 % mortality against stored product pests such as *Sitophilus* weevils (Asmanizar *et al*., 2008), and *Callosobruchus* seed beetles (Adebowale and Adedire, 2006). Therefore, the objective was to study the efficacy of

Jatropha curcas leaf extract associated with tomato in Minna, Niger State, Nigeria

MATERIALS AND METHODS

The research work was carried out in the Screen house of the Crop Production Department, Federal University of Technology, Minna. The site of the experiment is located in the Southern Guinea Savannah ecological zone of Nigeria. The experiment was located at 9 ^{0} 51 'N, 6 ^{0} 44 'E and 212 m above sea level as captured by Geographical Positioning System (GPS) equipment (GPS- 4300; Ethrex Garmin GPS, Taiwan). Niger State, Nigeria.

Jatropha curcas leaves were obtained from the School of Agriculture and Agricultural Technology *Jatropha curcas* plantation farm, Garatu village in Minna, Niger State. Two kilogrammes required for the experiment were collected and parked inside clean labelled polyethylene bags. These were transported to Department of Crop Production Laboratory, Federal University of Technology, Minna, Niger State.

Two kilogrammes of *Jatropha curcas* fresh leaves were washed and put inside mortar and pounded with a pestle into paste to which 200ml from 6 litres of required distilled water was added. The mixture was stirred with a clean glass rod and left on the laboratory bench for 24 hours. The pastes were covered with aluminium foil to prevent evaporation. After 24 hours, the mixture was stirred and poured into a whirling electronic tower blender for proper mixing for 1 minute. After blending, the pastes were poured into a plastic container and the remaining 5.8 litres of distlled water for each was added to the pastes. The pastes were left on the bench for 48 hour and covered with aluminium foil. After 48 hours, they were filtered into a clean container using Whatman No. 1 filter paper. The resultant solutions were labelled as standard concentration 'S for *Jatropha curcas* leaf (SJCL). Ten drops of Streptomycin sulphate were added to prevent bacterial formation and growth.

Treatments were different concentration levels which were prepared as undiluted standard solution 'S', half concentration of the standard solution S/2, one – tenth of the standard solution S/10, and one – hundredth of the standard solution S/100 using the method of (Bello *et al.*, 2006);

100 % (S) represented the standard stock concentration (undiluted), 50 % (S/2) represented 1ml of the standard concentration 1ml of distillled water added, 10 % (S/10) represented every volume of the standard concentration measured ten times of the distilled water was added, 1 % (S/100) represented every volume of the standard concentration measured hundred times its equivalent added and 0 % was the control (distilled water). The experiment was arranged in Completely

Randomized Design (CRD). Each concentration with the control were replicated 4 times for the extracts of *Jatropha curcas* leaves thereby making a total of 20 pots of 15 kg of sterilized soil. For each concentration of the extract, 15 ml of the extract was poured into each of the tomato pots using a measuring cup. Equal volume of distilled water was poured into similar sized pot and inoculated similarly to serve as control.

Data were collected on number of leaves, number of fruits, fresh and dry weight and root knot index. The number of leaves were counted from 1 week after Inoculation (WAI) to 12 Weeks After Inoculation (WAI) , the number of fruits were counted from the first day seed germinated till when the experiment was terminated, the fresh and dry weights were taken using the Metlar Balance and root knot index was done by counting the number of galls in the laboratory after harvesting the method of Bridge and Page (1980) after the experiment was terminated. All data were taken and recorded for each concentration for each hour.

Data collected were subjected to analysis of variance (ANOVA) using Statistical System Analysis (SAS) guide (SAS, 2008). Means were separated using Duncan Multiple Range Test (DMRT) at 5 % level of probability.

RESULTS AND DISCUSSION

The result in Table 1 shows that there was no significant difference in leaf number of tomato plants treated with the different concentration levels of leaf extract of *Jatropha curcas* at 1WAI, but significant leaf reduction was observed in the control with 15.25 as compared to S, S/2 and S/10. Similar increase in leaf number was observed in all the concentration levels between 2 and 5 WAI. However, at 6 WAI, significant effect of the concentration levels were observed in the leaf number differences between S with 52.63 and other concentration levels and the lowest decrease in leaf number was in the control with 30.75. Similarly, there were no significant differences in the number of leaves from plants treated with S/10 and S/100 at 6 WAI. The highest significant increase in leaf number of the tomato plants was observed in S as from 7 to 12 WAI where S attained the leaf number of 85.88 which was significantly difference from the other concentration levels S/2, S/10, S/100 and control with the leaf numbers 71.3, 66.13, 58.38 and 50 respectively. Gutlierrez *et al*., (2014) suggested that *Jatropha* leaf have a wide range of pesticidal and antimicrobial properties at standard solution. *Jatropha* leaf extracts at half standard solution kill the larvae of mosquito species that vector infectious diseases such as malaria (Valencia *et al*., 2006).

Table 1 Effect of different concentration levels of *Jatropha curcas* leaf extract on leaf number of tomato (*Solanum lycopersicum* L).

TRT	1WAI	2WAI	3WAI	4WAI	5WAI	6WAI	7WAI	8WAI	9WAI	10WAI	11WAI	12WAI
S	17.25a	29.13a	36.63a	40.25a	46.38a	52.63a	58.38a	64.75a	69.88a	74.95a	80.90a	85.88a
S/2	19.40a	25.2ab	30.63b	34.63b	38.88b	43.25b	46.91b	51.13b	55.88b	60.63b	65.50b	71.13b
S/10	17.13a	23.50b	28.8bc	32.3bc	36.3bc	40.6bc	44.7bc	48.8bc	52.7bc	57.25bc	61.00bc	66.13bc
S/100	16.63a	20.3bc	24.6cd	28.5cd	32.0cd	35.7cd	39.5cd	43.2cd	47.0cd	50.75cd	55.13cd	58.38cd
C	15.25a	18.50c	21.87d	24.38d	27.63d	30.75d	33.88d	36.50d	39.50d	43.00d	46.38d	50.00d
MEAN	17.13	23.35	28.52	32.13	36.25	40.6	41.68	48.9	53	57.32	61.78	66.3
±SE	1.58	1.65	1.75	1.49	1.55	1.63	1.93	2.38	2.58	2.77	3.06	3.32

Means with the same letters along the same column are not significantly difference ($p \leq 0.05$) from each other by DMRT
WAI= Week(s) after inoculation, TRT= Treatment, S = Standard solution, S/2 = Half Concentration of the standard solution
S/10 = One-tenth of the standard solution, S/100 = One – hundredth of the standard solution, C = Distilled water, DMRT = Duncan Multiple Range Test

Effect of different concentration levels of *Jatropha curcas* leaf extract on number of fruits, fruit weight, Root knot, plant fresh weight, plant dry weight of tomato against *Meloidogyne incognita*.

The result in Table 2 shows the number of fruits, fruit weight, root knot, fresh weight, dry weight of tomato inoculated with egg masses of *Meloidogyne incognita* under screen house conditions. The result shows that there was no significant difference in the number of fruits among concentrations S/2, S/10, S/100 and control with 1.25, 1.00, 0.50 and 0.25 respectively. The undiluted concentration level S recorded higher significant number difference of 3.50. Also, on fruit weight, there was no significant difference in the weight of the fruits among the concentration levels S/2, S/10, S/100 and control with 23.63g, 17.73g, 7.64 g and 2.46g respectively. The undiluted concentration recorded significantly higher fruit weight of 51.22 g. There was significant difference in the number of root knots from all the concentration levels. The control recorded the highest value for root knot of 7, followed by S/100 with 6, S/10 with 4, and S/2 with 2 the lowest value was recorded in the undiluted concentration S with 1.

There was no significant difference in fresh weights of S/100 and control with 18.19 g and 15.96 g respectively. However, concentrations S/2 and S/100 did not differ significantly with weights of 27.20 and 23 respectively. Whereas undiluted concentration S recorded the highest fresh weight of 35.68 g which differed significantly from the weights recorded from the remaining concentration levels. Results for the dry weights were similar as there was no significant difference between the weights from S/100 and control which recorded the lowest dry matter weight of 9.68 g and 8.98 g respectively. Also, there was no significant difference between the weights from S/2 and S/10 with 17.05 g and 15.57 g respectively. Whereas S with dry weight of 24.73 g differed significantly from the weights of the other concentration levels S/2, S/10, S/100 and control. This is in line with the report made by Onuh *et al*., (2008) that Jatropha leaf extracts at control level reduce fungal pathogen growth like brown blotch disease, and *Colletotrichum* spp in cowpea.

Table 2 Effect Of Different Concentration Levels Of Jatropha Curcas Leaf Extract On Number Of Fruit, Fruit Weight, Root Knot, Plant Fresh Weight And Plant Dry Weight Of Tomato (*Solanum Lycopersicum L*)

TRT	N.FR	FRWT (g)	RKN	PFWT (g)	DPWT (g)
S	3.50a	51.22a	1e	35.68a	24.73a
S/2	1.25b	23.63b	2d	27.20b	17.05b
S/10	1.00b	17.73b	4c	23.00bc	15.57b
S/100	0.50b	7.64b	6b	18.19cd	9.68c
C	0.25b	2.46b	7a	15.96d	8.96c
MEAN	1.3	20.54	4	24.01	15.2
±SE	0.57	7.21	0.27	1.82	1.06

Means with same letters along the same column are not significantly difference ($p \leq 0.05$) from each other by DMRT. TRT= Treatment, N.FR= Number of Fruit, FRWT (g) = Fruit Weight, RKN= Root knot, PFWT (g) = Fresh Weight, DPWT (g) = Dry Weight, S = Standard solution, S/2 = Half Concentration of the standard solution, S/10 = One-tenth of the standard solution, S/100 = One – hundredth of the standard solution, C = Distilled water, DMRT = Duncan Multiple Range Test

CONCLUSION AND RECOMMENDATION

The study revealed that the effectiveness of using different concentration levels of *Jatropha curcas* leaf extract for the control of *Meloidogyne incognita*. The Standard solutions (100 %) of *Jatropha curcas* leaf extract was more effective in the reduction of root knot formation and also enhanced the growth parameters of the tomato. Thus, *Jatropha curcas* leaf extract may be a source of cheap and effective nematicide for the management of *Meloidogyne incognita* without any threat to the health of man, animals and environment.

REFERENCES

Adebowale, K. O. & Adedire, C. O. (2006). Chemical composition and insecticidal properties of the underutilized *Jatropha curcas* seed oil. *Africa Journal of Biotechnology*, 5(10), 901-906.

Allen, A. (2008). "A Passion for Tomatoes". *Smithsonian magazine*. Pp 49-53.

Asmanizer,B.Djamin, A. & Idris, A .B. (2008).Effect of selected plant extract on mortality of adult *Sitopiluszeamais*Motschulsky (Coleptera: Curculionidae), a pest if stored rice grains. *Journal of Malaysian Applied Biology*, 37(2), 41-46.

Bello, L.Y., Marley, P.S., Chindo, P.S., &Alegbejo, M.D., (2006). Effects of some plant extracts on larval hatch on the root knot nematode *Meloidogyne incognita.Archives phytopathology and plant protection,*39(4), 253 – 257.

Bridge, J. & Page, S. L. J.; (1980). Estimation of root-knot nematode infestation levels on roots using a rating chart; Tropical Pest Management; 26:296–298.

Eisenback, J.D.H, Hirschmann, J.N, Sasser,J.N, &Triantaphyllou, A.C, (2007). A more complete characterization of the four most common species of root-knot nematodes (*Meloidogyne*spp.) with pictorial Key. IMP publication Raleigh, N.C.

Ellis,S.D., Boehm, M.J, and Rhodes, L.H. (2008).Nematode Diseases of Plants. Fact sheet on Agriculture and Natural Resources. 401-408

Fagbenro-Beyioku, A.F., Oyinbo, W.A., &Anuforom, B.C. (2006). Disinfectant/antiparasiticactivities of*Jatropha curcas*. *East Africa Medical Journal*, 75(9), 508-511.

Fairless, D. (2007) The Little Shrub that could-may be Nature, 449:652—655.

Food and Agriculture Organization. (2011). Production of Tomato by countries. Retrieved 30 June 2015; online at http://faostat.fao.org/site/339/default.aspx,

Food and Agriculture Organization. (2014). Production of Tomato by countries.Retrieved 30 August 2015.online at http://faostat.fao.org/site/339/default.aspx,

Fox,B, & Joseph A. (2001). Nematode Control in the Home Garden. Mississippi State University Extension Service Publication 483.Retrieved 30 August 2015; online athttp://msucares.com/pubs/pub483.htm

Gutlierrez, P.M., Antepuesto, A.N., Eugenio, B. A. L., and Santos, M. F. L., (2014). Larvicidalactivity of selected plant exracts, against the dengue vectors *Aedesaegypti*mosquito. *International Research Journal of Biological science* 3(4), 23-32.

Henning, R.K., (2002). *Using the Indigenous Knowledge of Jatropha – The use of Jatropha curcas oil as raw material and fuel*. IK Notes. No.47. August. World Bank.

Kimpinski J, &Sturz AV, (2003). Managing crop root zone ecosystems for prevention of harmful and encouragement of beneficial nematodes soil. Till Res 72; 213-221.

Kumar, A.,&Sharma, S(2008). An Evaluation of Multipurpose Oil Seed Crop for Industrial Uses (*Jatropha Curcas*L). Retrieved Online at http://www.elsevier.com/locate/indcrop on 5th November,2015.

Olabiyi,T.I., Olayiwola,O.O., &Oyediran,G.O. (2009).Influence of soil texture on distribution of phytonematode in the south western Nigeria. *World Journal of Agricultural Sciences*, 5(5), 557-560.

Onuh M.O., Ohazurike, N.C., &Emeribe, E.O (2008). Efficacy of *Jatropha curcas leaf* extract in the control of brown blotch disease of cowpea (Vignaunguiculata). *Journal of Biological Agriculture & Horticulture*, 25(3), 201-207.

Phowichit,S., Buatippawan,S. &Bullangpoti, V. (2008). Insecticidal activity of *Jatrophagossypifolia* L. (Euphorbiaceae) and *Cleome viscosa* L. (Capparidacae) on *Spodopteralitura* (Lepidoptera:Noctuidae). Toxicity and carboxylesterase and glutathione-s-transferase activities studies.*Community.Agriculture.Applied.Bioogical.Science*. 73(39), 611-619.

Rao,A.V., Balachandran,B., (2002). Role of oxidative stress and antioxidants in neuro degenerative disease. *Journal of Nutritional Neuroscience* 5(5), 291 - 309

Statistical Analysis System (SAS) (2008). Statistical Analysis System SAS/STAT Users guide,ver. 9. 2. SAS,Institute Inc., Cary N.c.

Trudgill, D.L, & Blok, V.C. (2001). Apomictic, polyphagous root-knot nematodes: exceptionally successful and damaging biotrophic root pathogens. *Annual Review Phytopathology*, 39:53–77

Valencia, A., Frerot, J.B., &Guenego,H. (2008).Effect of *Jatropha gossypiifolia* leaf extracts on three Lepidoptera species. *RevistaColombiana de Entomologia*32: 45-48.

Wang, R, Hanna, M. A, Zhou, W.W, Bhadury, P. S, Chen, Q. Song, B.A, & Yang, S. (2011). Production and selected fuel properties of biodiesel from promising non-edible oils:

Euphorbia lathyris L., *Sapiumsebiferum* L. and *Jatropha curcas* L. *Journal of Bioresources Technology*, 102(2), 1194 -1199.

78 EFFECT OF FOLIAR FERTILIZER APPLICATION ON PHYSIOLOGICAL CHARACTERISTICS AND HERBAGE YIELD OF AMARANTHUS AND CORCHORUS

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Abstract

One-third of children deaths in Africa are attributable largely to protein energy malnutrition and micronutrient deficiencies which can be solved by exploring underutilized nutritious crop. Experiment was conducted at the Crop Production Screen House and Albishiri Irrigation Farm both in Minna, during the dry Season of 2021. The objective was to determines the effect of application of organic foliar fertilizers rates on physiology and yield response of leafy vegetables in Minna. The experiment consisted of five rates of foliar fertilizer (0 L ha^{-1}, 0.5 L ha^{-1}, 1.0 L ha^{-1}, 1.5 L ha^{-1} and 2.0 L ha^{-1}) arranged in completely randomized design. Data were collected on plant height, The results indicated that plants that received organic foliar fertilizer rates at 2.0 L ha^{-1} produced significantly tallest plant at 4,5 and 6 WAS similar results were obtained for number of leaves, dry shoot weight. There was significant variation in the performance of the vegetables planted. Seeds had significant effects on fresh weight and dry weight of Amaranthus and Corchorus. it is therefore recommended that farmer should adopt the application of organic foliar fertilizer (Super Agro) at the rate of 2.0 L ha^{1}.

Keyword: Foliar Fertilizer, Amaranthus, Corchorus, Irrigation, Herbage yield

Introduction

Vegetable can be classified as fruit vegetables such as tomato, cucumber, okra; root and tuber/root vegetables such as potato, sweet potato, radish; green leafy vegetables such as amaranthus, celery, cabbage and bulb vegetables such as onion, garlic and shallot (Abewoy, 2018). Vegetable are important for nutrition in terms of bioactive nutrient molecules such as dietary fiber, vitamins, and minerals (Keatinge *et al.*, 2011). They are best resources for overcoming micronutrient deficiencies and provide smallholder farmers with much higher income and more jobs (Abewoy, 2018). Vegetable are produced all over the world but in a varied extent. Asia is the largest vegetable producer. China and India is the two largest vegetable producer of Asia cover 62 % of world's total production with an individual contribution of 554 and 127 million metric tons respectively (Shahbandeh, 2020). Bangladesh has also gained remarkable improvement in vegetable production in the last few years (Zaman, 2019). Therefore, the objectives are to determines the effect of foliar application of organic fertilizer rates on Physiology and yield responses of Amaranthus and Corchorus.

Material and methods

The experiment was conducted in the dry season of 2021 at the Crop Production Screen House, Federal University of Technology and Albishiri Irrigation Farm, Minna (9^{O} 37'N, 6^{O} 28'E) in the Southern Guinea Savanna of Nigeria. Soil samples were collected at random across the experimental site at the depth of 0 – 15cm along a transect and then bulked together to form the composite sample. Amaranthus and Corchorus varieties were obtained from the irrigation farmers in Minna, Niger State. Foliar fertilizer was obtained from an Agro-chemical shop in Minna. The Super gro fertilizer contained Nitrogen 72 g, Phosphorus 45 g, Potassium 30 g, Sulphur 15 g, Calcium 9 g, Magnesium 7 g, Iron 5 mg, Iodine 3 mg, Marine 1 mg and Zinc 1 mg per litre. The screen house experiment was a factorial combination of two vegetable varieties (Amaranthus and Corchorus) and five rates of folia fertilizer (Super Gro) (0 L ha^{-1}, 0.5 L ha^{-1}, 1.0 L ha^{-1}, 1.5 L ha^{-1} and 2.0 L ha^{-1}) resulting into ten treatment combinations. The experiment was laid out in a completely randomised design (CRD) with four replications resulting into 40 pots. The pots were watered (3liter) before planting and watered as when required to ensure the pots are kept moist. Watering will be done every other day until harvest. The field experiment was also a factorial combination of two vegetable (Amaranthus and Corchorus) varieties and five rates of folia fertilizer (Super Gro) laid out in a randomized complete block design (RCBD) with three replications resulting into 30 plots. The land was ploughed and levelled. The check basins of 3 m x 3 m were constructed. The gross plot size was 3m x 3m (9 m^2) and a net plot was 1.5 m x 3 m (4.5 m^2). An alley of 0.5 m was left within the replicates. In the field, the plots were irrigated a day to planting and immediately after planting. Irrigation was done twice a week. The field was irrigated to field capacity at each time of irrigation. Data were collected on plant height, number of leaves per plant, stem girth, number of branches, leaf area, number of days to 50 % flowering, fresh wet weight, dry weight, root length, fresh root weight and dry root weight. Data collected were subjected to analysis of variance (ANOVA) using the Statistical Analysis System (SAS) package version 9.0 (2013). Means were separated using Duncan Multiple Range Test (DMRT) at $P \leq 0.05$.

Results

The effect of foliar fertilizer rates on plant height of Amaranthus and Corhorus vegetables at 4, 5 and 6 WAS grown under screen house is shown in Table 1 Plant height was significantly different among the foliar fertilizer rates throughout the sampling periods of the study. At 4 WAS, the application of foliar fertilizer at the rate of 2.0 L ha^{-1} produced significantly taller plants than the other application rates compared with the control (0 L ha^{-1}) which produced the shortest plants. But that was not the case at 6 WAS were the application of foliar fertilizer at the rates of 0.5, 1.0 and 2.0 L ha^{-1} produced statistically similar tallest plants than the other rate compared with the control (0 L ha^{-1}) which had the shortest plants. At 6 WAS, the application of foliar fertilizer at the rates of 1.5 and 2.0 L ha^{-1} produced similar tallest plants than the other rates compared with the control (0 L ha^{-1}) which produced the shortest plants.

Table 1: Effect of foliar application of foliar fertilizer rates on plant height of Amaranthus and Corchorus vegetables at 4, 5 and 6 WAS grown under screen house

	Plant height (cm)		
	Weeks after sowing		
Treatment	4	5	6
Fertilizer (F) (L ha^{-1})			
0	28.85c	39.23c	46.95c
0.5	40.81b	60.18a	66.60b
1.0	50.85a	59.60a	67.60b
1.5	41.39b	52.43b	72.37a
2.0	51.83a	63.97a	73.60a
SE±	1.82	2.24	1.24
Vegetables (V)			
Amaranthus	58.62a	77.06a	89.92a
Corchorus	26.87b	33.11b	40.92b
SE±	1.15	1.42	0.78
Interaction			
F × V	**	**	**

Table 2: Interaction between foliar fertilizer application rates of Amaranthus and corhorus on plant height at 4, 5 and 6 WAS grown under screen house

	Vegetable	
	Amaranthus	Corchorus
Fertilizer (F) (L ha^{-1})	4 WAS	
0	34.77c	22.93e
0.5	54.79b	26.83de
1.0	74.69a	27.00de
1.5	57.01b	25.77de
2.0	71.83a	31.83cd
SE±	2.57	
	5 WAS	
0	52.66c	25.80e
0.5	87.56a	32.80de
1.0	84.57a	34.63d
1.5	70.69b	34.17d
2.0	89.81a	38.13d
SE±	3.17	
	6 WAS	
0	62.13d	31.77h
0.5	94.99bc	38.20g
1.0	93.36c	41.83fg
1.5	99.97a	44.77ef
2.0	99.15ab	48.04e
SE±	1.75	

Discussions

The tallest plants, highest number of leaves per plant, widest leaves, bigger stems, heavier fresh shoots and roots, heavier dry shoots and roots obtained with the application of foliar fertilizer (Super gro) at the rate of 2.0 L ha^{-1} could be attributed to the availability of sufficiently high content of macro and micro nutrients in the foliar fertilizer which in turn provided the plants with required nutrient that may be insufficiently supplied through the root system in the soil. This finding is in conformity with the results of Shafeeq *et al*. (2013) who reported that the superiority of highest levels of Stimufol foliar nutritional compound fertilizer at the highest levels of 200 g/fed in enhancing plant growth may be attributed to its high contents of macro and micro nutrients which provides the plants with required nutrients which one or more of them were insufficiently supplied through the root system in such low fertile soil. The authors also stated that foliar feeding is often the most effective and economical way to correct plant nutrient deficiencies. Abou-El-Nour (2002) reported that foliar application of nutrients could improve the nutrient utilization and lower environmental pollution through reducing the amounts of fertilizer added to soil.

Conclusions

From the results obtained from this study, it is concluded that the application of foliar fertilizer at the rate of 2.0 L ha^{-1} generally recorded significantly taller plants, higher number of leaves, wider stems and leaves, heavier fresh and dry fruits, higher ash content, crude protein content, fat content and crude fibre content under both screen house and irrigation conditions though statistically similar with application rates of 1.0 and 1.5 L ha^{-1} than the control (0 L ha^{-1}) which had the shortest plants, lowest number of

leaves per ant, smallest stems and leaves, lighter fresh and dry shoots and roots and lowest nutritional parameters measured in this study. Based on the context of this study, it is recommended that farmers in this agro-ecological zone of Nigeria should adopt the foliar application of folair fertilizer (Super gro) at the rate of 2.0 L ha^{-1} for higher growth, yield and nutritional qualities of Amaranthus and Corchorus

References

Abewoy D (2018). Review on Impacts of Climate Change on Vegetable Production and its Management Practices. Adv. Crop Sci. Tech 6:330. Doi:10.4172/2329-8863.1000330.

Abou-El-Nour, E. A. A. (2002). Can supplemented potassium foliar feeding reduce the recommended soil potassium? *Pakistan Journal of Biological Science*, 5(3), 259 – 262.

Keatinge JDH, Yang RY, Hughes d'A, Easdown WJ, Holme R (2011). The importance of vegetables in ensuring both food and nutritional security in attainment of the Millennium Development Goals. Food Sec. 3:491-501.

Shafeeq, M. R., Helmy, Y. I., Nadia, M. O & Rizk, F. A. (2013). Effect of foliar fertilizer with nutritional compound and humic acid on growth and yield of broad bean plants under sandy soil conditions. *Journal of Applied Sciences Research*, 9(6), 3674 – 3680.

Shahbandeh M (2020). Leading global producers of fresh vegetables 2017. Retrieved from https://www.statista.com/statistics/264662/topproducers-of-fresh-vegetables-worldwide.

Zaman ANMMU (2019). Vegetable farming growing rapidly.Published in the Daily Sun 13th January, 2019.Retrieved from https://www.dailysun.com/post/363732/Vegetable-farming-growing-rapidly

79 YIELD AND POD SHATTERING BEHAVIOUR OF SOME SOYBEAN GENOTYPES ACROSS LOCATIONS IN NIGERIA

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Abstract

Soybean producers in Nigeria are always interested in soybean varieties that can yield high with minimal seed loss through pod shattering. In view of the above, this study was conducted to evaluate the seed yield and pod shattering resistance of twenty-six (26) soybean genotypes. This was conducted in three locations across Nigeria during 2020 cropping seasons. In each location, the experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. After harvest, pod shattering evaluation was done using the sun-dry method. Data on seed yield and pod shattering were collected and analyzed using Analysis of Variance (ANOVA). Five genotypes (NCRI SOYAC78, NCRI SOYAC17, NCRI SOYAC69, NCRI SOYAC76, and NCRI SOYAC61) were outstanding in yield across the three locations, while Chinka having an average yield of 1.41 ton/ha, was the best among the locations. Out of outstanding genotypes, only NCRI SOYAC61 was not resistant to pod shattering. Therefore, farmers or researchers interested in a soybean genotype that can yield high and resist pod shattering could consider the other four genotypes.

KEY WORDS: Genotype, Location; Shattering; Soybean; Yield

INTRODUCTION

Soybean (*Glycine max* (L) Merril) is a grain 1egume that grows in tropica1 and sub tropica1, as well as temperate climatic conditions. It has the genetic potential to yield up to 4 ton ha^{-1}, if improved varieties are used (Hailu and Kelemu, 2014). However, according to United States Department of Agriculture (USDA, 2021), soybean production in Nigeria in 2019/2020 farming season was on an average of 0.88 ton/ha, in farmers' field. This achievement is not satisfactory considering soybean genetic potential. In Nigeria, Soybean is largely produced in the middle belt. However, its production in recent years has extended beyond these traditional areas to cover other Northern and Southern regions of the country (Ikeogu and Nwofia, 2013). The cultivation of this crop in Nigeria has been faced with some challenges including pod shattering and poor yield.

Pod shattering, which is the opening of mature pods along the dorsal or ventral sutures of the soybean pod and subsequent seed dispersal as the crop reaches maturity may result to a yield loss, which may be up to 100 %. It could be caused by the time of harvesting after maturity, environmental conditions, chemical composition of the pod wall; anatomical structure of the pod, and genetic factor of the variety (Krisnawati and Adie, 2017). In the major soybean production areas of Nigeria, the crop due to the time of planting, reaches maturity at the end of October or early November. Coincidentally, this is the period of rainfall cessation and the beginning of dry harmattan wind, with low relative humidity and rising temperatures, creating a suitable condition for pod shattering. Krisnawati and Adie (2017) ranked soybean genotypes with no pod shattering as very resistant; less than 25 % pod shattering as resistant, 25-50 % as moderately resistant; 21-75 % as highly susceptible; and greater than 75 % as very highly susceptible. The objective of this study is to identify and select some soybean genotypes with high yield and pod shattering resistance across locations in Nigeria.

MATERIALS AND METHODS

The study was conducted using 26 soybean genotypes (Table 1), in three locations in Nigeria during 2020 cropping season. The first location was in Minna, Niger State (Latitude 9.6737^{o}N, Longitude 6.5109^{o}E); the second was in Chinka, Kaduna State (Latitude 9.0535^{o}N, Longitude 7.3026^{o}E); while the third location was in Awka, Anambra State (Latitude 6.3437^{o}N, Longitude 7.0938^{o}E). The GPS coordinates were taken at the middle of each experimental site.

The field experiment was laid out in Randomized Complete Block Design (RCBD) with three (3) replications in each of the environments. The gross plot size was 6 m^2. The net plot size was 3 m^2. Gross plots within a replication were separated by a distance of 0.5 m, while an alley of 1 m separated one replication from the other. The total experimental area was 715 m^2. Two (2) soybean seeds were sown per hill. The planting distance used was 75cm × 20cm between and within rows, respectively. Single super phosphate (SSP) was applied at the rate of 40kg/ha at 2 weeks after planting. Manual weeding was done at 2 and 6 weeks after planting. Data were collected on seed yield and pod shattering percentage.

Pod shattering identification was done using sun-dry method (Krisnawati and Adie, 2016). Twenty pods were placed inside brown envelops and sun-dried for seven days. On the 7th day the number of shattered pods were counted and expressed in percentage. Data collected were subjected to Analysis of Variance (ANOVA) using General Linear Model (GLM) procedure of SAS. Levels of significance were determined at 5%. Means were separated using Duncan Multiple Range Test at $P<0.05$.

RESULTS

Weather

The peak of rainfall in each location was within the period of field experiment. The rainfall pattern was more fairly distributed in Minna and Chinka than in Awka. The highest annual rainfall was recorded in Awka (2777 mm), followed by Minna (1763.57 mm); while the lowest annual rainfall was recorded in Chinka (1031.4 mm). The maximum monthly temperature during the field experiment ranged from 28.9-35.7 ^{o}C in Minna; 28.7-35.3 ^{o}C in Chinka; and 29.8-34.6 ^{o}C in Awka. Interestingly, temperature was rising as the crop approached maturity and the hottest temperature in each environment during the field experiment was recorded in November, which was the month of harvest and pod shattering identification. The relative humidity ranged from 43-86 % in Minna; 43-85 % in Chinka; and 69-84 % in Awka. The relative humidity across the environments was fairly uniform, but there was an apparent decline as the crop was approaching harvest (October-November).

Yield

In Minna, NCRI SOYAC78 had the highest yield (1.53 tons/ha), which differed significantly from only NCRI SOYAC73, NCRI SOYAC26, NCRI SOYAC25, NCRI SOYAC28, NCRI SOYAC64, NCRI SOYAC9, NCRI SOYAC68, and NCRI SOYAC67. NCRI SOYAC25 on the other hand, was the lowest in yield (0.67 ton/ha). However, it differed significantly from only four genotypes namely; NCRI SOYAC78, NCRI SOYAC18, NCRI SOYAC17, and NCRI SOYAC29. In Chinka, NCRI SOYAC9 had the highest average seed yield (1.97 tons/ha), which differed significantly from only NCRI SOYAC18, NCRI SOYAC77, NCRI SOYAC73, NCRI SOYAC29, NCRI SOYAC64, NCRI SOYAC3, NCRI SOYAC7, NCRI SOYAC68, NCRI SOYAC20, NCRI SOYAC10, and NCRI SOYAC22. Conversely, NCRI SOYAC18 was the least in average seed yield (0.9 ton/ha) and it differed significantly from NCRI SOYAC17, NCRI SOYAC69, NCRI SOYAC26, NCRI SOYAC25, NCRI SOYAC65, NCRI SOYAC24, NCRI SOYAC9, NCRI SOYAC62, NCRI SOYAC75, and NCRI SOYAC76. The mean seed yields of NCRI SOYAC61 (1.4 tons/ha) and NCRI SOYAC25 (1.37 ton/ha) in Awka were the highest in this location, and they differed significantly from only NCRI SOYAC26, NCRI SOYAC29, NCRI SOYAC65, NCRI SOYAC24, NCRI SOYAC62, NCRI SOYAC63, NCRI SOYAC75, NCRI SOYAC10 and NCRI SOYAC67. The poorest in yield among the genotypes was NCRI SOYAC63 (0.7 ton/ha). However, it differed significantly from only five genotypes namely; NCRI SOYAC78, NCRI SOYAC18, NCRI SOYAC25, NCRI SOYAC9, and NCRI SOYAC61. Five genotypes (NCRI SOYAC78, NCRI SOYAC17, NCRI SOYAC69, NCRI SOYAC76, and NCRI SOYAC61) were outstanding in yield across the three locations, while the genotypes performed better in Chinka than in other locations (Table 1).

Pod Shattering

In all the locations, the highest pod shattering percentage was recorded in NCRI SOYAC63 (98.33 % in Minna, 80 % in Chinka and 90 % in Awka), and was significantly different from other genotypes. For low shattering genotypes in different locations, genotypes NCRI SOYAC78 and NCRI SOYAC7 that had the lowest pod shattering percentage in Minna (5 %), NCRI SOYAC28 that had the lowest pod shattering percentage (3.33 %) in Chinka, while NCRI SOYAC22 that had the lowest in Awka (1.67 %). Based on mean pod shattering percentage across the three locations and using the ranking of Krisnawati and Adie (2017), none of the genotypes was very resistant to pod shattering, twenty-one were resistant; four were moderately resistant, while only one was very highly susceptible.

Table 1 Mean yield (ton/ha) and pod shattering (%) of the genotypes across the three locations

	Yield (ton/ha)				Pod shattering (%)			
Genotype	Minna	Chinka	Awka	Mean	Minna	Chinka	Awka	Mean
NCRI SOYAC78	1.53a	1.47abcdef	1.33ab	1.44	5.00g	6.67fg	21.67bcde	11.11
NCRI SOYAC18	1.37abcd	0.90f	1.17abc	1.15	31.67b	48.33b	36.67bc	38.89
NCRI SOYAC17	1.47ab	1.67abc	1.07abcd	1.40	6.67fg	6.67fg	18.33bcde	10.56
NCRI SOYAC69	1.20abcde	1.70abc	1.13abcd	1.34	13.33defg	31.67bcd	25.00bcd	23.33
NCRI SOYAC77	1.23abcde	1.33bcdef	0.97abcd	1.18	10.00defg	8.33efg	3.33e	7.22
NCRI SOYAC73	0.73de	1.20cdef	1.03abcd	0.99	6.67fg	6.67fg	16.67cde	10.00
NCRI SOYAC26	0.83bcde	1.83ab	0.87cd	1.18	25.00bcd	6.67fg	18.33bcde	16.67
NCRI SOYAC29	1.40abc	0.97ef	0.87cd	1.08	8.33efg	13.33defg	10.00de	10.55
NCRI SOYAC25	0.67e	1.53abcde	1.37a	1.19	21.67bcdef	11.67defg	18.33bcde	17.22
NCRI SOYAC28	0.80cde	1.40abcdef	0.90bcd	1.03	11.67defg	3.33g	25.00bcd	13.33
NCRI SOYAC64	0.87cde	1.03def	1.03abcd	0.98	30.00bc	20.00cdefg	25.00bcd	25.00
NCRI SOYAC65	1.00abcde	1.57abcd	0.80cd	1.12	20.00bcdefg	30.00bcd	38.33b	29.44
NCRI SOYAC24	1.00abcde	1.87ab	0.83cd	1.23	11.67defg	16.67cdefg	26.67bcd	18.34
NCRI SOYAC3	1.10abcde	0.97ef	1.00abcd	1.02	18.33bcdefg	35.00bc	11.67de	21.67
NCRI SOYAC9	0.77cde	1.97a	1.20abc	1.31	11.67defg	18.33cdefg	21.67bcde	17.22
NCRI SOYAC7	0.97abcde	1.17cdef	1.00abcd	1.05	5.00g	18.33cdefg	8.33de	10.55
NCRI SOYAC68	0.87bcde	1.20cdef	1.13abcd	1.07	10.00defg	11.67defg	28.33bcd	16.67
NCRI SOYAC20	1.20abcde	1.30bcdef	1.13abcd	1.21	10.00defg	13.33defg	20.00bcde	14.44
NCRI SOYAC62	0.93abcde	1.57abcd	0.87cd	1.12	23.33bcde	15.00cdefg	25.00bcd	21.11
NCRI SOYAC63	1.27abcde	1.47abcdef	0.70d	1.15	98.33a	80.00a	90.00a	89.44
NCRI SOYAC75	1.10abcde	1.63abc	0.77cd	1.17	13.33defg	26.67cdef	25.00bcd	21.67
NCRI SOYAC10	0.93abcde	1.20cdef	0.90bcd	1.01	18.33bcdefg	8.33efg	25.00bcd	17.22
NCRI SOYAC67	0.83bcde	1.40abcdef	0.90bcd	1.04	16.67bcdefg	28.33bcde	26.67bcd	23.89
NCRI SOYAC76	1.00abcde	1.60abcd	1.13abcd	1.24	11.67defg	6.67fg	10.00de	9.45
NCRI SOYAC61	1.03abcde	1.47abcdef	1.40a	1.30	31.67b	21.67cdefg	26.67bcd	26.67
NCRI SOYAC22	0.97abcde	1.33bcdef	1.13abcd	1.14	15.00cdefg	50.00g	1.67e	7.22
Mean	1.04	1.41	1.02	1.16	18.65	19.17	23.21	20.34
±SE	0.23	0.21	0.15		5.57	7.06	7.16	
CV	38.47	25.25	26.02		51.68	63.84	53.45	

Means followed by the same letter(s) within a column are not significantly different at P≤0.05 using DMRT; ±SE = Standard error of the mean; CV = Coefficient of Variation.

DISCUSSION

The mean yield of all the genotypes across the three locations, which was best in Chinka, could be a reflection of adequate rainfall pattern in this location. Similarly, the high annual rainfall observed in Awka, which was higher than the recommended range of 700-1200 mm (Mondine *et al.*, 2001) could be responsible for the comparatively poor yield obtained in the location. The similar behaviours of the genotypes in pod shattering across locations, which was evident in NCRI SOYAC63 (highest across the locations) shows location had little or no influence on the pod shattering pattern of genotypes. This could be as a result of similar temperature and relative humidity levels observed across the locations since pod shattering behaviour of a soybean genotype is greatly influenced by these two climatic parameters (Zhang *et al*., 2018). This means that irrespective of location; some soybean genotypes can still exhibit the same level of resistance or susceptibility to pod shattering. This is in agreement with the findings of Bhor *et al*. (2014), which stated that the genotypic characteristics of any genotype play a key role in the overall expression of pod shattering of that genotype irrespective of climatic factors.

CONCLUSION AND RECOMMENDATION

The genotypes differed in their yield and pod shattering across the three locations. Five genotypes (NCRI SOYAC78, NCRI SOYAC17, NCRI SOYAC69, NCRI SOYAC76, and NCRI SOYAC61) were outstanding in yield across the three locations, while Chinka was the best location in terms of yield. Out of these five outstanding genotypes, only NCRI SOYAC61 was not resistant to pod shattering. Therefore, farmers or researchers could select the other four for optimum productivity.

REFERENCES

Bhor, T. J., Chimote, V. P., & Deshmukh, M. P. (2014). Inheritance of pod shattering in soybean [*Glycine max* (L.) Merril]. *Electronic Journal of Plant Breeding*, 5(4) 671-676.

Hailu, M. & Kelemu, K. (2014). Trends in soybean trade in Ethiopia. *Research Journal of Agriculture and Environmental Management*, 3(9), 477-484.

Ikeogu, U. N. & Nwofia, G. E. (2013). Yield parameters and stability of soybean [*Glycine max.* (L.) merril] as influenced by phosphorus fertilizer rates in two ultisols. *Journal of Plant Breeding and Crop Science*, 5(4), 54-63.

Krisnawati, A. & Adie, M. M. (2016). Pod shattering resistance in different soybean genotypes. *Proceedings of ILETRI National Seminar*. ILETRI, IAARD, Malang, 193-200.

Krisnawati, A. & Adie, M. M. (2017). Identification of soybean genotypes for pod shattering resistance associated with agronomical and morphological characters.*Journal of Biology and Biology Education*, 9(2), 193-200.

Mondine, M. L., Vieira, C. P. & Cambraia, L. A. (2001). Seeding time: an important factor affecting the productivity of soybean. *Dourados: Embrapa Agropecuária Oeste*,16, (Embrapa Agropecuária Oeste. Documentos, 34).

USDA (2021). World Agricultural Production. *Circular Series WAP* 7-21. July, 2021.

Zhang, Q., Tu, B., Liu, C. & Liu, X. (2018). Pod anatomy, morphology and dehiscing forces in pod dehiscence of soybean (*Glycine max* (L.) Merrill). *Flora* 248 (2018): 48-53.

80 EFFECTS OF ROOT KNOT NEMATODE (*MELOIDOGYNE INCOGNITA*) ON THE GROWTH PERFORMANCE OF OKRA (*Abelmoschus esculentus*) CULTIVARS IN MINNA, NIGERIA

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Abstract

Seeds of two okra varieties were tested against Root Knot Nematode (Meloidogyne incognita) in the screen house of School of Agriculture and Agricultural Technology, Federal University of Technology, Minna, Niger state, Nigeria. The root-knot nematode (Meloidogyne incognita) has been referred to as one of the most widespread nematodes severely injuring vegetables, it causes high losses to okra production. The experiment was a factorial combination of five inoculum by two variety resulting into ten treatments combinations replicated four times and arranged in Completely Randomized Design (CRD). Data were collected on plant height, number of leaves, stem girth and leaf area. Data collected were subjected to statistical analysis and means were separated using Least Significant Difference (LSD). The results indicated that there were significant (P < 0.05) differences among the levels of inoculation. However, okra plants inoculated with 2,4, 6 and 8) eggmasses produced plants with statistically similar lower height (27.7, 27.6 and 25.6cm) compared to other inoculum levels. Statistically similar lower number of leaves (1.8 and 1.0) were produced by the two varieties of plants inoculated with 6 and 8 eggmasses respectively. However, plants inoculated with4,6 and 8 eggmasses was significantly lower in plant stem girth (2.7cm) compared to other treatments. Statistically similar lower leaf areas were produced by plants inoculated with (6 and 8) eggmasses (38.9 and 37.3cm) respectively than other treatments. The findings indicated that inoculum of nematode (Meloidogyne incognita) had effect on okra at different stages of growth. The cultivation of moderately resistant cultivars in fields moderately infested with M. incognita would help reduce nematode reproduction enough to affect the residual nematode population

Key words: *Meloidogyne,* eggmasses, inoculation, sowing, soil sterilization.

Introduction

Okra (*Abelmoschus esculentus* L. Moench) originated from Ethiopia and was cultivated by the ancient Egyptians in the 12th century B.C.). It was domesticated in West and Central Africa but is now widely cultivated throughout the tropics primarily for local consumption. In Nigeria, it ranks third in terms of vegetable production and consumption, following tomato and pepper (Ijoyah *et al*., 2009). Okra is one of the most widely known and utilized species of the family Malvaceae (Naveed *et al*., 2009). Okra has great potential as foreign exchange earner and accounts for about 60 % of the export of fresh vegetables from India to the Middle East and European countries (Singh *et al*., 2014). Production of okra constitutes about 4.6 percent of the total staple food production in Nigeria. The crop contributes immensely to the economic status of farmers especially those engaged in large scale production of the crop in dry season and can be regarded as one of the crops which sufficiently contributes to food security since many families' plant okra as a garden crop (Roy *et al*., 2014). It is a multipurpose crop due to the various uses of its edible parts like the fresh leaves, buds, flowers, pods, stems and seeds (Yonas *et al*., 2014). Okra is a popular health food due to its high fibre vitamin C, and folate contents, it is also known for being high in antioxidants (Maramag *et al.*, 2013). The crop is also a good source of calcium and potassium, parts used are fruits, leaves and seeds. The juice of the roots is used externally in Nepal to treat cuts, wounds and boils (Sathish *et al.,* 2013). The optimum production of vegetables throughout the world is threatened by large number of biotic factors including plant-parasitic, nematodes (Hussain *et al.*,2016c). The root-knot nematode (*Meloidogyne incognita*) has been referred to as one of the most widespread nematodes severely injuring vegetables, it causes high losses to crop production particularly in infested fields of sandy soils (Ibrahim *et al*., 2010). Like all plant-parasitic nematodes, root-knot nematodes possess a stylet for injecting secretions as well as ingesting nutrients from host plant cells (Kayani *et al.*, 2017). Nematodes have no internal skeletal framework, and their "skin" or cuticle acts against internal turgor pressure to maintain body shape and aid locomotion. *Meloidogyne* extensively disrupt xylem tissues and greatly retard absorption and upward movement of water and nutrients (Silva *et al.*, 2015). Inadequate supply of water, nutrients, photosynthates and energy, growth and developments of leaf tissue and its constituents especially chlorophyll pigments are adversely affected (Hussain *et al.*,2016b). Poor growth of foliage subsequently leads to decreased production (Dhaliwal *et al*.,2012). The most reliable control of root-knot nematodes can be achieved by integrating two or more methods including an effective rotational scheme, resistant varieties, and selected cultural practices gives excellent control with little added cost (Collange *et al.*, 2014). Many vegetable farmers today have suffered lots of losses as a result of nematode infections, the root-knot nematode (RKN), *Meloidogyne incognita* has been referred to as one of the most widespread nematodes severely injuring vegetables (Hussain *et al.*, 2016a). During infection, dry matter accumulation in seeds is interrupted, hence maximum dry weight (Physiological Maturity) will not be reached resulting into poor seed viability Franca *et al*. (2012). Various methods have been used either singly or in combination of two or more methods which has resulted in varying degrees of effectiveness in the management of nematodes (Collange *et al.*, 2014). Root-knot nematodes are considered among the top five major plant pathogens and the first among the ten most important genera of plant parasitic nematodes in the world (Mukhtar *et al*., 2013b). Keeping in view the economic importance of *M. incognita* in reducing the quantity and quality of crop production, the present study is designed to determine the effects of different inoculum levels of *M. incognita* on the growth, fruit pod, yield and seed quality of two okra varieties which will help in the determination of economic threshold level in the control and management of the root knot nematode in the production of these two varieties of okra in Minna soils. Therefore, the objectives of the study were to help farmers identified nematode infections and consequences in other to reduce and manage the occurrences for optimum yield.

Materials and Methods

The study was carried out in 2019 growing season at the Screen House of School of Agriculture and Agricultural Technology, Federal University of Technology at Gidan Kwano Campus, Minna. Minna is located between Latitude 9^0 31' N and Longitude 6^0 29' E, (Lawal *et al*., 2012). Seeds of two Okra varieties (NHAe-47 and LD88) were sourced from National Horticulture Research Institute (NIHORT) Ibadan, Nigeria. Topsoil of (0-15 cm) depth was collected from the Teaching and Research and Farm of Federal University of Technology, Minna. The collected soil was sterilized using a metal tray for one hour at 98.5 ^{0}C with fire wood as the source of heat Salaudeen and Aguguom (2014) The sterilized soil was spread on a large metal sheet after heating and left over night to cool off before it was used. Sterilized soil was thoroughly mixed and fill into forty (40) polythene pots each of 10.6kg. The experiment was a factorial combination of two okra varieties (NHAe-47 and LD88) by five inoculums (control, 2 eggmasses, 4 eggmasses, 6 eggmasses, 8 eggmasses) resulting into ten treatment combinations and arranged in Completely Randomized Design (CRD) with four replications. Five seeds of each cultivar were sown into 10 kg sterilized soil in a hole at the depth of 3 centimetres Two weeks after emergence, seedlings were thinned to two plants per stand in each pot. The inoculum used for the experiment was the eggmasses of root knot nematode (*Meloidogyne incognita)* which was obtained from the roots of heavily infested okra plant (*Abelmoschus esculentus*), cultured in the Screen House of School of Agriculture and Agricultural Technology, Federal University of Technology, Minna. Eggmasses, okra plant roots infected with *M incognita* were uplifted from pots, washed under a running tap water, cut into approximately 1-2 cm pieces and was vigorously shaken in a bottle containing 0.5 % Nacl for 5 minutes to remove adhering soil (Hussey and Barker,1973). The eggmasses were collected on a 38 μm sieve and washed in a beaker and the eggmasses collected into plastic Petri dishes labeled according to different levels of treatment for inoculation. Three weeks after planting grooves were created around the base (2.0 cm) from the plant, eggmasses of *M. incognita* were inoculated and gently covered for all the replicates. Water was applied to each pot every 24 hours to field capacity. Pots were kept constantly moist; water application was done early in the mornings and to field capacity, daily. Weeds were controlled by hand pulling in each polythene pot as found necessary throughout the period of the research work. Plant height was taken from the base of the plant to tip of apical leaf (cm) using meter rule, number of leaves were counted and recorded, Vernier calliper was used to determine stem girth for all replicates. Leaf area was determined by taking length and breadth multiplied by constant K, (Musa *et al.*, 2016). Data were collected based on plant height, number of leaves, stem girth and leaf area per plant. Data collected were subjected to general linear model analysis of variance (ANOVA) using Statistical Analysis System (SAS) package version (2017). Means were separated using Least Significant Different (LSD) at 5% level of probability.

Results and Discussion.

The results of the experiment on effects of inoculum (*M. incognita)* and variety on growth performance of two okra varieties inoculated at different levels as showed in (Table 1) indicated that okra plants inoculated with (2, 4, 6 8) eggmasses produced significantly lower heights respectively which were statistically similar compared to control plants with significantly higher (53.3cm) height. However significant differences in height was not recorded amongst the two okra varieties. The results in (Table1) indicated that two varieties of okra plants inoculated with 6 and 8 eggmasses produced statistically similar lower number of leaves (1.8 and 1.0) respectively compared to control plants with significantly more leaves (7.4). However significant differences was recorded amongst the two varieties: NHAe47-4 recorded more number of leaves (3.30) than LD88 which recorded (2.55) number of leaves. Results showed in (Table1) indicated that plants inoculated with (4, 6 and 8) eggmasses were significantly lower in plant stem girths (2.8,2.8 and 2.7cm) which were statistically similar vaues compared to control plants with significantly larger stem girth, however no significant differences was recorded amongst the two varieties in stem girth. While the results showed in (Table1) indicated that two varieties of okra plants inoculated with 6 and 8 eggmasses produced leaf area which were statistically similar (38.9 and 37.3cm) respectively compared to other treatments. Significant differences in leaf area was recorded amongst two varieties: LD88 produced larger (53.17cm) leaf area than NHAe47-4 which recorded (49.47cm) leaf area. Therefore, significant reduction in growth observed on aerial parts of all the treated plants during the study such as plant height, fewer number of leaves, reduction in leaf area and stem girth per plant compared to control plants, may be attributed to damages caused by nematode when they became sedentary and established feeding sites on the roots of treated plants which consequently resulted to poor growth as observed on growth parameter during this study, this agrees with the report of (Silva *et al.*, 2015)who stated that *Meloidogyne* extensively disrupt xylem tissues and greatly retard absorption and upward movement of water and nutrients. (Hussain *et al.*,2016b) in his report stated that due to the inadequate supply of water, nutrients, photosynthates and energy, growth and developments of leaf tissue and its constituents especially chlorophyll pigments are adversely affected, this is supported by (Kayani *et al*. 2017) who in his report opined that poor growth of foliage subsequently leads to decreased production. (Dhaliwal *et al*.,2012) also in his report stated that plants with infected roots are more susceptible to other diseases caused by fungi and bacteria and tend to stop producing early. The findings on the effects of inoculum (*Meloidogyne inconita)* which caused reduction in plant height, number of leaves, stem girth and leaf area in this study showed significant differences among okra cultivars in their responses to *M. incognita*. Two okra varieties investigated indicated that inoculum of nematode (*Meloidogyne incognita*) also had significant effects on all levels of inoculation. Therefore, effects of inoculum of (*M .incognita*) caused significant reduction on plant height, number of leaves, stem girth and leaf areas on two okra varieties investigated. Similarly, significant differences were recorded amongst the two varieties on number of leaves and leaf areas throughout the study. Cultivation of moderately resistant cultivars in fields moderately infested with *M. incognita* would help reduce nematode reproduction enough to affect the residual nematode population densities, as uninterrupted cultivation of susceptible cultivars is aggravating the root-knot problem. The approach will also help to minimize environmental pollution, preserve the agro-ecosystems and biodiversity and keep management processes more economical. Furthermore, these cultivars could be used in breeding programs to introduce new resistant cultivars to these nematodes in the area of study.

Table 1 Effects of inoculum (*M. incognita*) and variety on the growth performance of okra

Treatments	Plant height (cm)	Number of leaves	Stem girth(cm)	Leaf area(cm)
Inoculum (I)				
Two (2) eggmasses	30,0b	2.5b	2.9b	52.4 b
Four (4) eggmasses	27.7bc	2.0b	2.8 bc	46.1 c
Six (6) eggmasses	27.6bc	1.8bc	2.8 bc	38.9 d
Eight (8) eggmasses	25.6 bc	1.0 c	2.7 c	37.3 d
Control	53.6a	7.4a	3.7 a	81.8 a
SE ±	1.50	0.49	0.07	2.73
LSD	3.07	0.99	10.12	5.56
Variety (V)				
NHAe47-4	33.12a	3.30a	3.01 a	49.47 b
LD88	32.95a	2.55b	3.01 a	53.17 a
SE ±	0.95	0.30	0.05	3.52
LSD	1.94	0.63	0.10	0.10
Interaction				
I x V	NS	NS	NS	NS

Means with the same super script within column are not significantly different at ($P< 0.05$) level of probability

References

Collange, B., M. Navarrete, F. Montfort, T. Mateille, J.Tavoillot, B. Martiny and M. Tchamitchian (2014).Alternative cropping systems can have contrasting effects on various soil-borne diseases: *Relevance of a systemic analysis in vegetable cropping systems. Crop Protection*. 55: 7-15.

Dhaliwal, G.S., O. Koul, S. Khokhar and R. Singh (2012). Bio pesticides in Environment And Food Security: Issues And Strategies. *Scientific Publishers*,pp 492

França Neto, J. B., Pádua, G.P., Krzyzanowski, F.C., Carvalho, M.L.M. de, Henning, A.A. and Lorini, I. (2012).Semente Esverdeada de Soja: Causas e Efeitos sobre o Desempenho Fisiológico – Série Sementes. [Soybean Green Seeds: Cause and Effects on the Physiological Performance], *Circular Técnica* 91, *embrapacnpso, Londrin*.

Hussey, R.S. and K.R. Barker. 1973. A comparison ofmethods of collecting inoculum of Meloidogyne spp including a new technique. *Plant Diseases*. Rep. 57: 1025

Hussain, M. A., Mukhtar, T. and Kayani, M. Z. (2016a). Reproduction of *Meloidogyne incognita* on resistant and susceptible okra cultivars. *Pakistan Journal of Agricultural Sciences,* 53, 371- 375.

Hussain, M.Zouhar.,M., Rysanek,P. and Anwar, S.A.,(2016b). Relationship between *Meloidogyne incognita* density and plant growth of okra. *Journal of Animal and Plant Science.*, 26 : 739-744

Hussain, M., M. Kamran K. Singh M.Zouhar,P.Ryšáne and S.A Anwar (2016c). Response of selected okra cultivars to *Meloidogyne incognita*. *Crop Protection*. 82:1-6.

Ijoyah, M.O., Atanu, S.O. and Unah, P.O.(2009). Productivity of okra (*Abelmoschus esculentus* L.) Moench) varieties as influenced by seasonal changes in Makurdi, Nigeria. *Proc. of 27th Annual Conference of the Horticultural Society* of Nigeria held at Kano, Nigeria 11 – 16 Oct. 2009 pp159 - 165 Medagam, T. R., Mutyala, H. B., Konda, C. R.,

Ibrahim, I.K.A.; Mokbel, A.A. and Handoo, Z.A. (2010). Current status of phytoparasitic nematodes and their host plants in Egypt. *Nematropica* 40(2): 239-262.

Kayani, M. Z., Mukhtar, T. and Hussain, M. A. (2017). Effects of southern root knot nematode population densities and plant age on growth and yield parameters of cucumber. Crop Protection, 92, 207-212http://dx.doi.org/10.1016/*journals of crop production*. 2016.09.007. [Links]

Lawal, B.A., Adeboye, M.K.A. Tsado, P.A., Elebiyo,M.G. and Nwajoku, C.R. (2012). Properties,classification and agricultural potentials of lateritic soils of Minna in sub-humid agroecological zone, Nigeria. *InternationalJournal of Development and Sustainability*,1(3):903-911

Maramag, R. P.(2013). Diuretic potential of *Capsicum frutescens* L., *Corchorus oliturius* L., and *Abelmoschus esculentus* L. *Asian journal of natural and applied science*, 2(1). 60-69.*Meloidogyne incognita*. *Crop Protection*. 44: 13–17.

Mukhtar, T., I. Arshad, M.Z. Kayani, M.A. Hussain, S.B. Kayani, A.M. Rahoo and M. Ashfaq. (2013a). Estimation of damage to okra (Abelmoschus esculentus) by root Hussain,Mukhtar and Kayani 31 4 knot disease incited by *Meloidogyne incognita*. *Pakistan. Journal of.Botany*. 45: 1023-1027.

Musa, U.T., and Usman, T. (2016). Leaf Area Determination for Maize (*Zea mays* L), Okra (*Abelmoschus esculentus* L.Moench) and Cowpea (*Vigna inguiculata* L) crops using linear measurement. *Journal of Biology, Agriculture and Healthcare* www.iiste.org ISSN 2224-3208 (Paper) ISSN 2225-093× *(Online)* .6, No. 4.

Naveed, A., A.A. Khan and I.A. Khan, (2009). Generation mean analysis of water stress tolerance in okra (*Abelmoschus esculentus* L.*). Pakistan Journal of Botany,* 41: 195-205.

Roy, A., Shrivastava, S. L., & Mandal, S. M. (2014). Functional properties of Okra *Abelmoschus esculentus* L.(Moench): traditional claims and scientific evidences. *Plant Science Today*,*1*(3) 121-130.

Sathish, D.,and Eswar, A. (2013). A Review on*: Abelmoschus esculentus* ("Okra"). *International Resources Journals of Pharmaceutical and Applied Sciences*., 2013;3(4):129-132.

Singh, B., Singh, P. M., Sanwal, S. K., and Pal, A. K. (2014). Standardization of cost effective hybridization technique for hybrid seed prospection in okra (*Abelmoschus esculentus*). *Indian Journals of Agricultural Sciences.* 84, 1111–1114.

Silva, R.V., Oliveira, R.D.L., Ferreira ,P. S., Castro,D.B. and Rodrigues. F.A. (2015) . Effects of silicon on the penetration and reproduction events of *Meloidogyne exigua* on coffee roots. *Bragantia*, 74,196 -199.

Saludeen,M.T. and Auguom , A.(2014). Indentification of some cowpea accessors tolerant to cowpea mild mottle virus. Society for science and nature. *International journal of science and nature,*5 (2), 261—267.

Yonas, M., Garedew, W., & Debela, A. (2014). Multivariate analysis among okra (*Abelmoschus esculentus*) collection in South Ethiopia. *Journal of Plant Sciences, 9* (2), 43.

SOYBEAN (Glycine max (L) Meriil) GENOTYPE STUDY IN THE SOUTHERN GUINEA SAVANNA OF NIGERIA

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Abstract

Effective identification of superior genotypes is generally complicated by the presence of Genotype (G) Environment interactions, whereby cultivar relative yields vary across different environments. The study was conducted to ascertain genotype x environment on soybean genotype in Southern Guinea Savanna of Nigeria the established cultivars in terms of yield component adaptability to an ecology field experiment were conducted from developed genotypes in Southern Guinea Savanna Ecology of Nigeria. Ilorin, Ibadan and Niger State during the 2020-2021 Cropping Session application of P^{ha-1} resulted in significantly higher genotypes in NCRI- SOY AC73 than other genotypes were significantly different between the two Cropping session while there was no significant variation for grain yield in other genotypes and hence good adaptability while the former ones shows unstable productivity under adverse condition resulting from rainfall pattern in 2020 and 2021 thus were deemed unsuitable for the Southern Guinea Savanna Ecology which is highly prone to drought conditions. Data collected were subjected, Correction Analysis Number of Leaves, Plant Height, and number of branches in conclusion, NCRI-SOY AC73 was best adapted to the Southern Guinea Savanna.

Key Words: Adaptability, Southern Guinea Savanna, soybean genotype, Environmental

Introduction

Soybean (Glycine max (L.) Merrill) is one of the most important oil seed crops in the world. The crop has gained popularity in Nigeria, outranking cowpea (Vigna unguiculata (L) Walp), because of its potential to supply high quality protein (Akande et al., 2007). Soybean production constitutes 6 % of all arable land in the world and has the highest percentage increase in area under production among crops annually. The global demand for the crop is expected to increase due to the crop's potential to improve the dietary quality of the vast majority of people and livestock (Hartman et al., 2011). Stability analysis is performed to estimate the performance of genotypes as linear function of the level of productivity in each environment (Bernardo, 2010).

Materials And Methods

Study Location

The experiment was conducted in three different locations across the Southern Guinea Savanna

The use of multiplicative models which include the additive main effect and multiplicative interaction (AMMI) model has also been used to assess the stability of other crops (Adjebeng-Danquah, *et al*., 2017). The AMMI model allows fitting of the sum of several multiplicative terms rather than only one multiplicative term in dissecting the performance of genotypes in different environments (Bernardo, 2010). Also suggested the use of the genotype and genotype × environment interaction (GGE) biplot to graphically visualize genotypic performance across several environments. The use of these strategies will enable the breeder to make informed decisions in where to place which variety based on their adaptability for optimum performance.
Nigeria; namely: Ilorin in Kwara state Nigeria, NCRI Apata, Ibadan, Oyo state, Nigeria and Minna, Niger state, Nigeria. The study was conducted during the raining season of 2021.

Source of Seeds
The Ten genotypes t used were obtained from Niger State River Basin Development Authority.

Treatments and Experimental Design:
The treatments were NCRI SOY AC78, NCRI SOY AC18, NCRI SOY AC17, NCRI SOY AC69, NCRI SOY AC77, NCRI SOY AC73, NCRI SOY AC26, NCRI SOY AC29, NCRI SOY AC25, NCRI SOY
AC28. These were arranged in randomized

complete block design, with three replications in all the locations

1. Agronomic Practices Land preparation
   This was done manually by clearing the bushes and preparing the ridges.
2. Sowing of seeds
   Each genotype of soybean entry will be planted in three 4-mrows, with spacing of 60cm between rows and 5cm between plants.
3. Weed control

Weed control was achieved by pre-emergence application of stomp (Pendimenthalin 500) immediately after planting and supplemented with one hand weeding at five weeks after planting (WAP).

4. Harvesting

Plots were harvested by hand in October 2021 and then threshed by plot harvester for seed yield and other seed traits determinations.

5. Data Collection

Environmental Data Collected in Each Location

i. Mean monthly rainfall(mm)

ii. Mean monthly temperature (oC)

iv. Branches per plant: was done by counting

plant each from each plot number of branches of the plants in the middle rows, their average computed and recorded.

v. Leaf area: the leaf area of the 5 plants each in the middle rows was measured, using a leaf area meter at constant of 6.

vi. Days to 50 % flowering: was recorded when half of the 5 plants each in a net plot flowered. This will be done through visual observation.

iii. Mean monthly relative humidity (%)

Growth Data

The following growth data were collected:

Emergence (%): was calculated using the formula below, according to Baset Mia and Shamsuddin (2009):

Emergence (%) = number of emerged sedling x 100

Expected number of plants

Plant height: This were measured on plants in the middle rows at 4, 8 and 12 weeks after planting (WAP) using meter rule and/tape. It was measured from ground to the last leaf of the main shoot. The average height of the

5 selected plants were computed and recorded.

Number of leaves: was done by counting the visible leaves on the 5 plants each in the middle rows and average number was taken and recorded.

vii. Days to maturity: was calculated from the sowing date to the date where 95 % of the 5 plants each in the net plot reached maturity.

Yield Data

Pods per plant: was counted manually from the 5 plants each in the middle rows during harvest and were recorded.

Seeds per pod: Twenty (20) pods were randomly selected from each genotype, the number of seeds they contain was counted and their average taken and recorded.

Above ground biomass (kg/plot): This was taken by weighing the above ground part of all the plants in net plot during harvest, using a weighing balance.

i. Seed yield (kg/plot): The weight of seeds harvested per net plot was measured using a weighing balance

ii. Harvest index: was determined by using the formula described by Kemanian et al. (2007). This is given below: Harvest index = Seed yield Above ground biomass

Statistical Analysis: Data collected were subjected to the using Statistical Analysis Software (SAS)

Table 1: Performance of 10 soybean accessions for 15 agro-morphological traits across three locations

Sources	Germ %	NL at 1Month	NL at 2Month	NL at 3Month	NB at 1Month	NB at 2Month	NB at 3Month	PH at 1Month
Locations (L)	5064.02**	97.07**	1242.53**	2837.053**	14.01**	63.95**	3214.28**	75.81**
Genotypes (G)	104.79**	57.39**	168.54**	568.27**	1.62**	8.49**	18.41**	24.93**
G x L	126.11**	12.73**	87.33**	635.52**	2.55**	9.06**	23.64**	11.53**

Sources	PH at 2Month	PH at 3Month	Biomass (kg)	100seed weight (g)	No of pods	Seed yield (kg/plot)	Harvest index
Locations (L)	90.88**	1249.37**	0.09**	1.34ns	1951.30**	0.078**	0.01ns
Genotypes (G)	23.00**	100.96**	0.07**	2.67**	8170.04**	0.12**	0.02**
G x L	40.83**	107.31**	0.03**	1.39ns	7830.52**	0.07**	0.01**

Discussion

Mean performance for germination and Number of Leaves Per Plant among 10 Soybean Accession three locations was not significant difference among Number of pods per plant and grain yield the soybean genotype varied significantly for Number of leaves per plant among 10 Plant Height, Number of Branches per plant among 10 accessions at three locations 2021 genotype x interactions effects were significantly different for both number leaves, plant height and number of branches .across the year of study number of leaves per plant recorded the highest with NCRI SOY AC73 Mean Performance of 10 soybean accessions for 15 agro morphological tracts across three location shows that NCRI-SOY-AC13 has the highest Number of Leaves Number of Branches which was significantly difference from other genotypes. Genotypes NCRI-SOY-AC69 Produce the highest Number of pod which was similar to other genotype genotypes NCRI-SOY-AC77 produces the highest number of seed weight.

Conclusion

The results of study revealed substantial genetic variability in the genotypes evaluated for most of the traits .high genotypic coefficient of variations were observed for NCRI SOY AC75, Number leaves, Plant height and Number of branches and plant biomass of the soybean genotypes.

Recommendation

NCRI SOY AC75 produce Number leaves, Plant height and Number of branches and plant biomass these strategies will enable the breeder to make informed decisions variety

based on their adaptability for optimum performance in southern Guinea Savanna.

References

Adjebeng-Danquah, J., Manu-Aduening, J., Gracen, V. E., Asante, I. K. and Offei, S. K. (2017) AMMI stability analysis and estimation of genetic parameters for growth and yield components in cassava in the forest and Guinea savannah ecologies of Ghana. International Journal of Agronomy 2017,1-12.

Akande, S. R., Owolade, O. F. and Ayanwole, J. A. (2007). Field evaluation of soybean varieties at Ilorinin the southern guinea savanna ecology of Nigeria. Afr. J. Agric. Res. 2(8): 356-359.

Bernardo, R.(2010). Breeding for Quantitative Traits in Plants. Woodbury, MN: Stemma Press; 2010.

Kemanian, A R., stockle , CO., Huggins D.Rand Viega L.M(2007) Asimple method to estimate harvest index in gain crops Field crops Research, 103, 208- 216

Hartman, G. L., West, E. D. and Herman, T. K. (2011). Crops that feed the World 2. Soybean worldwide production, use and constraints caused by pathogens and pests. Food Security 3:5-17.

81 EFFICACY OF SOME BOTANICAL EXTRACTS ON THE MANAGEMENT OF FALL ARMYWORM *(Spodopterafrugiperda*J.E. SMITH*)* ON MAIZE *(Zea mays* L.*)*

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ABSTRACT

Afieldexperimentwasconductedduring2021rainyseasonattheTeachingandResearchfarmofSchoolofAgriculture and Agricultural Technology, Federal University of Technology Minna, Gidan Kwano campus to evaluate the efficacy of some botanical extracts for the management of Fall Armyworm on Maize.The treatments were arranged in Randomized Complete Block Design (RCBD) with three replicates.Growth and yield parameters were recorded. The data were subjected to Analysis of Variance and means were separated using Duncan multiple rang test. The results revealed that botanical extracts had varie effectsamongthesix(6)plantbotanicalswithNeemleavesextractshavingthelowestinfestation,alsohad thehighestnumberofplantheight,stemdiameter,freshyieldweight,dryyieldweightandgrainyieldweight.Therefore,the useofNeemleavesextractwasrecommendedforthemanagementoffallarmywormofmaize.

Key words: Maize; botanical extracts; *Sporodeptera frugiperpa;* variety; pests

INTRODUCTION

The management of insect pests largely depends on the use of synthetic insecticides in the field and store. However, indiscriminate use of many synthetic insecticides, human technical's, environmental non target organisms, resistance of insect pest, food and product contamination with toxic residue, biodiversity, erosion and other side effects (Sallam and Allsopp, 2002). In addition, non-availability of insecticides to country side farmers and ventilation restriction in stored grain are the negative effects of synthetic chemicals. As a result, organochlorine has been reportedly banned in developed countries. These resurcitated the idea of botanical insecticides as a promising alternative to pest control. Botanical insecticides are naturally occurring chemical extracted from plants which break down readily in the soiland are not stored in plant or animal tissue. Often their effect are not long lasting as those of synthetic pesticides (Ebenezer, 2010). Botanical insecticides are generally pest – specific and are relatively harmless to non-target organisms. They are biodegradable and harmless to the environment. Also, the possibility of insect developing resistance to botanical insecticide is less likely (Isman, 2013). Laboratory and field tests have shown the effectiveness of this plant extracts against armyworm, leaf-cutting caterpillars, ants, whiteflies and the three stages of mosquitoes (Zhen and Zhang, 2000).

Fall army worm (FAW) can be one of the most difficult insect pests to control in field corn ((Pogue 2002). Late planted field and late maturing hybrids are more likely to become infested. Fall army worm causes serious leaf feeding damage as well as direct injury to the ear. Fall army worm can damage corn plant in nearly all stages of development, it will concentrate on later plantings that have not yet silked(FAO, 2018). Therefore, this research work was to test for the efficacy of some botanical extracts such as Neem leaf extract, Red stem fig leaf extract, Flamboyant leaf extract, Billy goat weed leaf extract, Moringa leaf extract and Masquerade leaf extract as bio pesticides to control the infestation of fall armyworm of maize crop and boost yield of maize crop in Nigeria. Therefore, the objective was to determine the most effective botanical in the management of fall army worm of maize.

MATERIALS AND METHODS

Experimental Site

The field experiment was conducted during 2021 rainy season at the Teaching and Research farm of School of Agriculture and Agricultural Technology, Federal University of Technology Minna, Gidan Kwano campus (latitude 6 ° 33'E and Longitude 9 ° 37'N, with altitude 1475 m above sea level) located in the Southern Guinea Savannah agro-ecological zone of Nigeria. It has a peak temperature of 40 °C from March to April. The mean annual rainfall ranges from 120-130mm. (Ojanuga, 2006). The soil type varies from loamy or silty loam soil or silty clay loam.

Source of Experimental Materials

A maize variety OBA 98 was obtained from the Department of Crop Production, Federal University of Technology Minna, Niger state, Nigeria.

Preparation and Application of Botanical Leaf Extract

The botanical leaves were plucked around the school Premises, School of Agriculture and Agricultural Technology, Federal University of Technology, Minna, Niger state.The leaves of six different botanicals were collected and washed with clean water. 1 kg of the leaves was weighed using weighing balance scale (sensitive weighing balance manufactured by Metler instruments LTD) in the Laboratory. After weighing, the leaves were then choped with the use of knife into smaller pieces and blended (electric blender) with 1 litre (L) of Distilled water and mixed properly. Aluminium foil was used to cover the concentration to prevent evaporation, dirt and dust, after which the samples were kept for 24 hours on the laboratory bench to undergo fermentation, after 24 hours, the solution was stirred and sieved using muslin cloth and was labeled. Half litter of the botanical extract was added to 2 liters of water for the spraying of maize plant using knapsack sprayer.

Experimental Design and Field Layout

The experiment was arranged in Randomized Completely Block Design (RCBD) with three replicates. The net plot size was 14 x 24 m^2. Each replicate consisted of 7 plots, replicate measuring 4 x 24 m^2 and each plot measuring 4 x 3m^2. Each plot consists of five ridges with 1 m as alley between the replicate and 0.5 m between plots. Plant spacing is 75 cm between rows and 25 cm within row.

Cultivation Practices

The first fallow was cleared with hand implements such as hoes and machete in order to keep the soil loose for good seedbed and subsequent effective germination and seedling emergence. Land was prepared manually in form of ridge of 3 m long, sowing was done at the full establishment of rainfall. Maize seeds were sown two per hole with inter-row and intra-row spacing of 75 cm and 25 cm respectively. Plant was thinned to one per stand at 2WAS, weeding was done at 3 and 6 WAS. At three weeks after sowing, (WAS) NPK 20:10:10 fertilizer was applied by side placement at the rate of 9.6 g per plant (5 cm away from the plant stand) at 3 WAS using a bottle cover of NPK 20:10:10 as source. At six weeks after sowing and three weeks after application of N. P. K 20:10:10 fertilizer, urea fertilizer was applied at the rate of 9.6 g per plant (5 cm away from the plant stand) at 6 WAS using a bottle cover of urea as source, this is to complete the N requirement of the crop

Data Collection

Ten plant samples were randomly selected and measured from the ground level to the tip of the tallest leaf using a meter rule at 10WAS.The stem diameter of ten plants were measured by using Vernier Calliper at 10WAS. Ear rot was rated on a scale of 1-5, where 1= little or no visible ear rot and 5 = extensive visible ear. The number of days from planting to the time when 50 % of the plants have tasseled shading polar were counted and recorded. The number of ear per plant was counted, Fresh weight was taken after harvesting of the plant using electronic weighing balance. Dry weight was taken after sun drying the maize using electronic weighing balance. Grain weight was done after threshing from the cob using electronic weighing balance. Plant stand was physically checked for the appearance of Fall Armyworm infestation.

Fall Armyworm severity was determined by scoring Armyworm damage to maize plant, using the following scale;

Visual rating damage reaction	Numerical score	Resistant
No damage	0	likely escape
Few pin hole	1	highly resistance
Few short holes on few leaves	2	Resistance
Several short holes (<50%)	3	Resistance
Several leaves with short holes (>50%)	4	Moderately resistance
Elongated lesion on a few leaves	5	Moderately resistance
Elongated lesion on several leaves	6	Susceptible
Several leaves with long lesions or tattering	7	Susceptible
Sever tattering	8	Highly Susceptible
Plant drying as a result of foliar damage	9	extremely sensitive to damage.

Source: CIMMYT, (2011)

Data Analysis

The data collected were subjected to Analysis of Variance (ANOVA) using Statistical Analysis System (SAS) procedure version 9, 2002 model. The treatment means were separated using Duncan Multiple Range Test (DMRT) at 5 % probability level.

RESULTS AND DISCUSSION

Before the application of the botanical extracts, all of the treatments plots have been infected by Fall Armyworm Table 1, but there was no significant difference in the infestation rate among the treatments plots with Masquerade leaf extract recording the highest infestation rate followed by Red stem fig leaf extract, Neem leaves, while control and Flamboyant leaves recorded similar infestation rate, Billy goat weed and then Moringa recorded the lowest infestation rate.

After the first, second and third applications, there were no significant difference among the botanicals except in the case of control which differs significantly ($P \leq 0.05$) from the botanicals.

Table 2 showed the plant height and number of days to 50 % tasseling of maize. There was no significant difference among the treatments to attain 50 % tassseling. Similarly, there was no significant different among the botanical extracts on plant height. Neem leaf extracts recorded the highest plant height followed by Control, Masquerade leaves extracts, Red stem fig leaf extracts, Moringa leaves extracts, Billy goat weed leaves extracts, respectively and shortest plant height was recorded on Flamboyant leaves extracts, but were not significantly different from one another. This result disagrees with the earlier model of Thornley (1998) that increase in stem diameter of infected plant will lead to decrease in the plant height while increase in plant height will result to decrease in stem diameter of the plant.

Table1: Effect of botanical extracts on the incidence of fall armyworm.

Treatment	Before application	After first application	After second application	After third application
Neem leaf	5.10	2.43b	1.23b	0.63c
Red stem fig leaf	5.90	3.73b	2.60b	1.80bc
Control	5.00	4.90a	5.30a	5.47a
Flamboyant leaf	5.00	3.37ab	2.70b	2.00b
Billy goat weed	4.93	3.20ab	2.53b	1.63bc
Moringa leaf	4.53	3.70ab	2.47b	1.73bc
Masquerade leaf	6.07	3.70ab	2.33b	1.47bc
SE±	0.24	0.24	0.30	0.34

Means with the same letter(s) in the same column are not differ significantly according to Duncan Multiple Range Tests at 5 % level of probability. SE± (Standard error of mean).

Table 2: Effect of botanical extracts on the plant height and number of days to 50 % tasseling.

Treatment	Parameters		
	Plant height(cm)	Number of days to 50% tasselling	
Neem leaf	210.40	52	
Red stem fig leaf	204.23	52	
Control	207.53	52	
Flamboyant leaf	191.43	52	2
Billy goat weed	198.97	52	
Moringa leaf	199.20	52	
Masquerade leaf	204.77	52	
SE±	3.98	0.00	

Means with the same letter(s) in the same column are not differ significantly according to Duncan Multiple Range Tests at 5 % level of probability. SE± (Standard error of mean).

Table 3: Effect of botanical extracts on the number of ear per plant and number of rotten ear.

Treatment	Parameters	
	Number of ear per plant	Number of rotten ear
Neem leaf	1.23	1.80b
Red stem fig leaf	1.27	1.93b
Control	1.00	3.80a
Flamboyant leaf	1.17	1.80b
Billy goat weed	1.10	1.67b
Moringa leaf	1.07	1.80b
Masquerade leaf	1.07	1.80b
SE±	0.04	0.19

Means with the same letter(s) within the same column are not differ significantly according to Duncan Multiple Range Tests at 5 % level of probability. SE± (Standard error of mean).

Table 3 showed the number of ear per plant and number of rotten ear of maize. Number of ear per plant was not significantly differed among the botanical extracts. Red stem fig leaves had the highest number of ear per plant followed by neem leaf extract flamboyant leaves, billy goat weed leaves, while moringa leaves and masquerade leaves had similar number of ear per plant and then control having the lowest. There was significant difference between control and the botanical extracts, but there no significant difference among the botanical extracts with control recording the highest number of rotten ear and significantly ($P \leq 0.05$) different from botanical extracts.

Table 4 showed the stem diameter and fresh cob weight of maize. There was no significant difference among the botanical extracts with respect to stem diameter despite that Neem leaves recording the highest stem diameter followed by Moringa leaves and Red stem fig leaves, while Masquerade leaves recorded the thinnest stem diameter. Similarly, no significant difference among the botanical extracts on fresh yield weight. Neem leaves recorded the highest fresh yield weight followed by Red stem fig leaves, Flamboyant leaves, Moringa leaves, Control, Billy goat weed leaves and least was recorded in Masquerade leaves.

Table 5 showed cob weight and grain yield weight.There was no significant difference among the botanical extracts on the cob weight. Neem leaves recorded the highest cob weight followed by Red stem fig leaves, Flamboyant leaves, Moringa leaves, Control, Billy Goat weed leaves and the lowest was recorded at Masquerade leaves. Similarly, there was no significant difference among the botanical extracts on the grain yield weight. The highest was recorded from Neem leaves followed by Red stem fig leaves, Moringa leaves, Flamboyant leaves, Billy goat weed leaves, control and the lowest was recorded in Masquerade leaves. According to Nailul *et al*. (2018), research conducted in Andalas University Padang, Indonesia, that botanical extract of *Gentiana linearis* recorded the highest plant height, leaf area, fresh cob weight and grain yield which was in conformity to this study The study also confirm the study (effect of moringa leaf extract on growth and yield of maize) conducted by Biswasn *et al.*, 2016,which showed that there was positive effects of moringa leaf extract on the number of leaf, root length, fresh weight and grain yield of maize. Similarly it also confirm another study on the (Yield performance of maize treated with neem seed extracts against stem borers) by Wahed I *et al.*, 2016 which shows that neem seed extracts were effective in protecting the maize plants from maize stem borers infestation.

Table 4: Effect of botanical extracts on stem diameter and fresh cob weight of maize.

Treatment	Parameters	
	Stem diameter	Fresh cob weight
Neem leaf	5.63	193.41
Red stem fig leaf	5.33	179.18
Control	5.11	154.42
Flamboyant leaf	4.79	165.75
Billy goat weed	5.08	150.27
Moringa leaf	5.52	164.72
Masquerade leaf	4.66	140.59
SE±	0.16	6.63

Means with the same letter(s) within the same column are not differ significantly according to Duncan Multiple Range Tests at 5 % level of probability. SE± (Standard error of mean).

Table 5: Effect of botanical extracts on cob weight and grain yield weight of maize.

Treatment	Parameters	
	Cob weight	Grain yield weight
Neem leaf	116.78	100.05
Red stem fig leaf	98.86	83.36
Control	89.12	75.21
Flamboyant leaf	95.63	78.62
Billy goat weed	88.80	75.93
Moringa leaf	92.96	79.10
Masquerade leaf		
SE±	82.93	71.19
	3.91	3.40

Means with the same letter(s) within the same column are not differ significantly according to Duncan Multiple Range Tests at 5 % level of probability. SE± (Standard error of mean).

CONCLUSION

From the result obtained above, it was concluded that Neem leaves extracts had the lowest infestation in most of the parameters taken. Neem leaf had the highest number of plant height, stem diameter, fresh yield weight, dry yield weight and grain yield weight. This showed that, the use of Neem leaves botanical extracts on the management of fall armyworm of maize had low fall armyworm infestation.

REFERENCES

Biswas, A., Hoque, T., andAbedin, M. (2016). Effects of moringa leaf extract on growth and yield of maize. Progressive Agriculture, 27(2), 136 - 143. httpsP//doi.org/10.3329/pav27i.29322. blog.farmcrowdy.com/maize-economic-importance-nigeria/

CIMMYT. (2011). Meeting world maize needs: Technological opportunities and priorities for the public sectors. Mexico D F. CIMMYT. 60 p.

Ebenezer, O. O. (2010). Managemet of major field pests and yield of cowpea (*Vigna unguiculata* (L) Walp) under calendar and monitored application of synthetic chemicals in Asaba, Southern Nigeria. *African journal of General Agriculture* .6 (3):177-186.

F. A. O. (2018). Integrated management of the Fall Armyworm on maize: A guide for Farmer Field Schools in Africa.

Isman, M. B. (2013). Botanical insecticides, deterrents, and repellents in modern agriculture and an increasingly regulated world. Annual Revision of Entomology, 51: 45- 66.

Nailul, J.T., Prasanna, B.M., Vasal, S.K., Kassahun, B., and Singh, N.N. (2018).Andalas University Padang, Indonesia. The search for economic friendly in control of insect pest infestation.81(10), 1308–18.

Pogue, M.G. (2002) A world revision of the genus Spodoptera Guenée (Lepidoptera: octuidae). *Memoirsof the American Entomological Society 43, 1–202.*

Sallam, M. S. & Allsopp, P. G. (2002) Chilo incursion management plan (Version 1). *Bureau of Sugar Experiment Stations, Queensland, Australia.*

Shen, Y.C.andZhang, Y.B. (2000). Biopesticides, Chemical Industry Press, Beijing.

Thornley, J. H. M. (1998). Modellingshoot:root relations: the only way forward? *Annals of Botany 81: 165–171.*

Wahedi, J. A., Obadiah, J., Sambo, E., Elizabeth P.D. and Chabiya, W. (2016). Effect of plant oil treatments against *Sitophiluszeamais.* (Coleoptera: Curcolionidae) on stored maize. pp. 57 – 67. A journal of experimental botanical extracts evaluations.

82 RESPONSE OF *CORCHORUS OLITORIUS* (JUTE MALLOW) CULTIVARS INFECTED WITH ROOT-KNOT NEMATODE (*MELOIDOGYNE INCOGNITA)* TO PRE-SOWING TREATMENT

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Abstract

The study was conducted to evaluate the Response of Corchorus olitorius cultivars infected with Root-knot nematode to pre-sowing treatment with Candle bush extract. Four cultivars of Corchorus olitorius, NGB00229 (A), NGB00209 (B), NGB00277 (C) and NGB00215 (D) were evaluated for physiological and morphological parameters. Number of leaves, plant height, leaf area, biomass weight (fresh and dry) and root gall index were used as agronomic indices. Seeds were treated using the recommended heat treatment method in order to break seed dormancy. Seeds were sown using the Completely Randomized design (CRD), with four replications and the C. olitorius cultivars as the treatment. Data collected were analyzed using the analysis of variance (ANOVA) and the means were separated using Student-Newman Keul's Test (SNK) at 5% level of probability. Results showed significant differences in most of the traits evaluated for the four cultivars except for the number of pods and their relative weights which was not significantly different. Cultivars NGB00215 showed the least resistance to root knot nematode while other cultivars were highly resistant. Also, cultivars A performed best in most of the parameters taken such as the number of leaves, with (127) leaves while cultivars B (102), C (86) and D (84). The present study indicated enough variation among the extract concentrations with the 100, 75 and 50 (%) concentrations having higher indices than the 25 and 0 (%) levels, which can in turn help to broaden the genetic bases of new cultivars to reduce nematode insurgence.
Keywords: cultivars; traits; root knot nematode; concentrations and physiological parameters.

Introduction

Nematodes or roundworms as described by Hodda, (2011) and Zhang, (2013), are a diverse animal phylum inhabiting a broad range of environments. Nematodes are very small, slender worms, typically about 5 to 100 µm thick, and 0.1 to 2.5 mm long, Weischer and Brown, (2000). The body is often ornamented with ridges, rings, bristles, or other distinctive structures (Lalosevic *et al*., 2013). Chitwood, (2016), reported that global losses associated to root-knot nematodes (RKNs) alone from 75 countries as at 2000 was valued at $121 billion. Phytoparasitic nematodes are considered as hidden enemies, which can cause yield losses up to 80% in vegetables and have been associated with the severely infested fields (Tariq-Khan *et al* .,2017).

Corchorus olitorius L., commonly known as wild okra, belongs to the family Tiliaceae. It is widely consumed as a vegetable among rural communities in most parts of Africa (Velempini *et al*., 2003). In West Africa it is commonly cultivated and very popular among people of all classes especially in Nigeria (Oyedele *et al*., 2006). According to Zakaria *et al*. (2006), wild okra is used in folklore medicine in the treatment of gonorrhea, chronic cystisis, pain, fever and tumors. *Corchorus olitorius* is known to contain high levels of iron and folate which are useful for the prevention of anemia (Oyedele *et al*., 2006).

Senna alata is an important medicinal tree, as well as an ornamental flowering plant in the subfamily Caesalpinioideae, which grows well in forest areas of West Africa (Owoyale *et al*., 2005). The result of the qualitative analysis of the leaf carried out by Sun *et al.*, (2009), indicated that alkaloids, quinones, saponins, phenolic compounds, flavonoids, tannins, and anthraquinone were present.

According to Islam, (2013), the most serious pests of *C. olitorius* are nematodes from the genus *Meloidogyne*, leaf-eating beetles and caterpillars. Application of insecticides is also possible, but agent and application time should be chosen carefully since the leaves are harvested for consumption. The mineral composition of the leaves of *C. olitorius* revealed high concentrations of Mg, Fe and Ca. It should be noted that the fruit is rich in total lipid while the stem has good fiber content; this makes the entire aerial parts of this plant important and explains the use of the plants as a fiber crop (Roy *et al*., 2006). Therefore, the objectives were to:

(i) to determine the most effective concentration(s) of *Senna alata* extract for pre sowing treatment on the growth of *Corchorus olitorius* infected with *Meloidogyne incognita*.

(ii) to determine the best cultivar(s) of *Corchorus olitorius* that can tolerate the inoculum level of *Meloidogyne incognita.*

Materials and Methods

Source of plant accessions

Four cultivars of jute mallow which includes *corchorus* NGB00229; NGB00209; NGB00277 and NGB00215 were obtained from the National Center for Genetic Resources and Biotechnology (NACGRAB), Ibadan, Oyo State, Nigeria. While the leaves of *Senna alata* were collected from a fully grown and mature tree in Gurara, Minna, Niger State.

Laboratory experiment

Conical flasks of 250 ml in volume and Polyethylene bags were used for this research work. The conical flasks were arranged on the laboratory bench in a Completely Randomized Design (CRD). For each of the extract, 200 ml of each of the concentration levels was poured into the conical flasks after steeping (pre soaking in hot water) using a pipette. At the beginning of the experiment, four hundred (400) seeds of the four cultivars of *Corchorus olitorius* was transferred into hot water with a temperature of 93 ºC and allowed to soak for 10 seconds to overcome dormancy using four different conical flasks labeled NGB00229 (A), NGB00209(B), NGB00277 (C) and NGB00215 (D). After 10 seconds, these seeds were sieved out using a filter paper and transferred into the various solutions labeled S (100 %), S (75 %), S (50 %), S (25 %) and the control (distilled water). This was done to allow the seeds further absorb each of the extract in order to increase their viability and germination capacity while increasing their anti-nematicidal properties prior to inoculation. The seeds were allowed to soak further for 10 minutes and later air dried which took place 24 hours before sowing in the nursery. The treatments were replicated four times and a control which was kept at an ambient temperature ranging from 30°C-34°C in the laboratory during the course of the research. The experiment was a 4×5 treatment combination making a total of 20 treatments combinations.

Pot Experiment

The pot experiment was conducted under screen house conditions. Poly pots (16 cm by 25 cm) were filled with 2 Kg sterilized soil in the ratio 3: 1 (sandy loam: farmyard manure). Each pot was inoculated with 10 egg masses of *M. incognita* containing about an average of 200 larvae by making grooves around the roots at the same distance from the base. Data collection began two weeks after inoculation and continued on a weekly basis for a period of eight weeks. The data was analyzed for parameters such as: number of leaves/plant, leaf area, plant height, number of pod/plant, biomass fresh/dry weight and root gall index. Most of the cultivars were found immune according to the rating scale. Data was analyzed using the analysis of variance (ANOVA) and the means were separated using Student-Newman Keul's Test (SNK) at 5% level of probability.

RESULTS

Table 1 revealed the resistance rating of the cultivars, NGB00229, NGB00209, NGB00277 (highly resistant), and NGB00215 (moderately resistant). However, as the plants grew older, significant differences were observed. In the third week after inoculation (WAI), the number of leaves produced by cultivars A (82^{a}), was observed to be the highest but was not significantly different at $p \leq 0.05$ from cultivars B (74^{ab}) and D (65^{b}), however it differed statistically from cultivars C (48^{c}), having the lowest number of leaves due to *Meloidogyne incognita* infection. Furthermore, it was evident from the analysis carried out that cultivar NGB00229, performed best in the number of leaves produced as it was significantly different at $p \leq 0.05$ from the other cultivars as it was not affected by *Meloidogyne incognita* infection. The least number of leaves was observed in cultivar NGB00215 which behaved similarly for other parameters. There were slight differences in the root gall index with cultivar NGB00215 showing the highest susceptibility to root-knot nematode infestation as indicated in table 1.

Table 1: Reproduction of Root knot nematode on the five cultivars and resistance rating of the nematode

Cultivars	Root Gall Index	Reaction
NGB 00229	0.900^{b}	highly resistant
NGB 00209	1.700^{b}	highly resistant
NGB 00277	1.850^{b}	highly resistant
NGB 00215	4.450^{a}	moderately resistant
SE	±0.399	

Values in each column followed by the same letters are not significantly different according to Duncan's Multiple Range Test ($P \leq 0.05$).

Table 2: Effect of *Meloidogyne incognita* on the number of leaves of different cultivars of *Corchorus olitorius* across five concentration levels.

Cultivars	Concentrations	Week 1	Week 3	Week 5	Week 7
NGB00229 (A)		32^{a}	82^{a}	120^{a}	127^{a}
	100 (%)	30^{a} (± 2.1)	75^{a} (±4.7)	131^{a} (±7.6)	117^{a} (±8.6)
NGB00209 (B)		33^{a}	73^{ab}	101^{ab}	102^{b}
	75 (%)	27^{a}	73^{a}	116^{ab}	97^{a}
NGB00277(C)		17^{b}	48^{c}	92^{b}	86^{b}
	50 (%)	26^{a}	61^{a}	98^{ba}	100^{a}
NGB00215 (D)		28^{a}	62^{b}	98^{b}	84^{b}
	25 (%)	25^{a}	63^{a}	81^{c}	90^{a}
	0 (%)	28^{a}	63^{a}	92^{a}	94^{a}
SE±		1.90	4.20	6.76	7.73

Values in each column followed by the same letters are not significantly different according to Duncan's Multiple Range Test ($P \leq 0.05$).

Discussion

Most of the plant growth characters of the jute mallow cultivars were significantly negative correlated with the number of galls of *M. incognita*. Moreover, it can be suggested that egg masses also had an indirect effect on the reduction of plant growth. *Meloidogyne* spp. induces galling in the roots and giant cells formation in the stellar region, which destroys the xylem tissues and ultimately reduces the absorption and movement of water and nutrients (Abad *et al*., 2003). The limitation of nutrient elements in the plant is one of the initial effects that the nematode infestation has on the physiology and metabolism of its host (Lu *et al*., 2014). These effects increase with the duration of infestation (Malakeberhan *et al.*, 1987). In conclusion, the current study demonstrated that the four cultivated *C.olitorius* cultivars are highly resistant to *M. incognita* with the exception of the cultivar NGB00215, which was found moderately resistant after pre-sowing the seeds with *Senna alata* extract. Also, the highest concentration (100%) of *Senna alata* performed the best when compared to other concentration levels in reducing the effect of root-knot nematode infestation.

Conclusion and Recommendation

It can be concluded from the study that there was a low incidence of *Meloidogyne incognita* in this study area. Furthermore, Adopting proper management techniques such as sourcing of highly resistant cultivars seeds from reliable agricultural institutes, regular weeding, as well as effective seed treatment with the adequate plant extract is capable of reducing disease incidence of *Meloidogyne incognita* (root-knot nematode) in *Corchorus olitorius* (jute mallow). This is required in screening for nematode-resistant varieties for increased yield in jute mallow production at a reduced cost.

Reference

Abad, P., Favery, B., Rosso, M. & Castagnone-Sereno, P. (2003). Root-knot nematode parasitism & host response: molecular basis of a sophisticated interaction. M*olecularPlantPathology*,4: 217- 224.

Chitwood, D., J. (2016). *Nematicide*, USDA-ARS, Beltsville, MD, USA, http://www.ars.usda.gov/SP2UserFiles/person/990/Chitwood2003.Nematicide

Review.pdf.

Islam, M. (2013)."Biochemistry, Medicinal and Food values *(Corchorus capsularis L. and C .olitorius L.) leaf: A Review" (PDF). International Journal of Enhanced Research in Science Technology & Engineering. 2 (11): 35–44.*

Lalošević, V.; Lalošević, D.; Capo, I.; Simin, V.; Galfi, A.; Traversa, D. (2013). "High infection rate of zoonotic *Eucoleus aerophilus* infection in foxes from Serbia". Parasite. 20: 3.

Lu, P., Davis, R.F., Kemerait, R.,C., Iersel, M.,W. and Scherm, H. (2014). Physiological Effects of *Meloidogyne incognita* Infection on Cotton Genotypes with Differing Levels of Resistance in the Greenhouse. *Journal of Nematology*, 46(4): 352-359.

Owoyale, J., A, Olatunji G., A., and Oguntoye S., O. (2005). Antifungal and antibacterial activities of an alcoholic extract of *Senna alata* leaves. *Journal of applied sciences and environmental* management 9 (3), 105-107.

Oyedele, D., J., Asonugho, C. and Awotoye, O,.O. (2006). Heavy metals in soil and accumulation by edible vegetables after phosphate fertilizer application. *Electoral Journal of Agricultural Food Chemistry*, 5:1446-1453.

Roy, A., A.; Bandyopadhyay, A., K.; Mahapatra, S., Ghosh, K. and Singh, N., K. (2006). Evaluation of genetic diversity in jute (*Corchorus* species) using STMS, ISSR and RAPD markers. *Plant Breeding*, 125, 292-297.

Sun H., Xie Y., Ye Y. (2009). Advances in saponin-based adjuvants. Vaccine. 27(12):1787-1796.

Tariq-Khan M, Munir A., Mukhtar T., Hallmann J., and Heuer H. (2017). Distribution of root-knot nematode species and their virulence on vegetables in northern temperate agro ecosystems of the Pakistani-administered territories of Azad Jammu and Kashmir. *Journal of Plant Disease Protection*, 124 (3), pp. 201-212

Velempini, P., Riddoch, I., and Batisani, N.(2003). Seed treatments for enhancing germination in wild okra (*Corchorus olitorius*). *Experimental Agriculture*, 39: 441-447.

Weischer B., Brown D., J. (2000). An Introduction to Nematodes: General Nematology. Sofia, Bulgaria: Pensoft. pp. 75–76. ISBN 978-954-642-087-9.

Zakaria, Z.A., Somchit, M., N., Zaiton, H., Mat Jais A., M., and Sulaiman, M., R. *et al*., (2006). The *in vitro* antibacterial activity of *Corchorus olitorius* extracts. *International Journal on Pharmacology*, 2: 213-215.

Zhang, Z. (2013). "Animal biodiversity: In: Animal biodiversity: an outline of higher-level of classification and survey of taxonomic richness (addenda 2013). Zootaxa 3703:5-11.

83 EFFECT OF FRUIT AGES ON MOTHER- PLANT SEED QUALITY OF "EGUSI" MELON (*Cucumeropsis manni Naudin*) CULTIVARS

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Abstract

Melon fruits produced at the base of the stem are older. Age reduces as they get closer to the apex of the stem. Melon farmers however, conduct harvest operation on the same day and do not grade fruits according to their ages and position on the mother- plant before extraction of seeds. The experiment was conducted in 2019 at the laboratory of Crop Production Department, Federal University of Technology, Minna to evaluate the qualities of two "egusi" melon cultivars harvested at different ages on their mother-plant. The treatments were three harvesting stages, 23, 33. 43 days after anthesis *(DAA) and two "egusi" melon cultivars ("paragi" and "ofe"). The seeds were placed on filter paper moistened with distilled water in plastic dishes and laid out in Completely randomized design (CRD) in four replications. Data were collected on seed length, dry seed weight, seed diameter, 100-seed weight and germination percentage. Data collected were subjected to analysis of variance (ANOVA) and means were separated using Tukey's test. The results indicated that, the "Paragi" variety recorded significantly higher values for all the observed seed parameters except seed length and seed diameter. The results also revealed 23 days after anthesis had significantly lower values compared to 33 and 43 days after anthesis for 100-seed weight, number of seeds per fruit and weight of seed. For seed length and seed diameter, 43 days after anthesis was significantly higher. The germination percentage between the two varieties were generally similar throughout the duration of storage. Though significant germination percentage differences were recorded among the seeds harvested at different days after anthesis at 0, 6, 8, 10, 12 and 14 storage periods, the trend was not consistent. Seed of cultivar "Paragi" retained higher quality traits. For optimum storability and good seed quality, "egusi" melon should be harvested at 43 days after anthesis.*

Keywords: "Egusi" Melon, Seed Quality, Germination percentage

INTRODUCTION

"Egusi" melon (*Cucumeropsis manni*) is the biological ancestor of the watermelon now found all over the world. It is a member of the cucurbitaceae family and the genus *Citrullus* (Ogbonna and Obi, 2010). Melon consisted of 4 to 5 species of the genus, viz: *Cucumeropsis manni* (thumb), *Citrulus colocynthis* (L) Sachred, *Citrullus ecirrhorous* (Cogn) and *Citrullus naudrnianus* (Sord Hook), with the basic chromosome number of 2n =22, n=11 (Ogbonna, 2013). The word "Egusi" is derived from Yoruba language, (Vossen *et al.*, 2004). Bello (2011), stated that "egusi" melon is a native of African where it was cultivated for many centuries. It has been referred to *Citrullus vulgaris* in some texts (Ogbonna and Obi, 2007) and *Cucumeropsis manni (*Ogbonna, 2013). " Egusi" melon is now wide spread in all tropical, sub-tropical and warm temperate (hot summers) regions of the world, including Africa. The kernels of its seed can be eaten as snacks when roasted and used for the purpose of cooking oil source (Bande *et al*., 2012). According to Demir and Smith (2001); Oladiran and Kortse (2002) and Demir *et al*, (2004) seed age is a major determinant of seed quality. Most small-holder farmers obtain fruits that have been left to weather on the field; which are most likely to be seeds from fruits of different position and ages, such seeds are known to be of poor quality. Such seeds are known to germinate poorly when planted. This has over the years resulted in low productivity among peasant vegetable growers as they are usually unable to access improve and high-quality seed due to high cost. Therefore, the objective of the study was to evaluate the variabilities in the qualities of two "egusi" melon cultivars harvested at different ages.

MATERIALS AND METHODS

The experiment was conducted in 2019 at the laboratory of Crop Production Department, Federal University of Technology, Minna, Niger State (latitude 9^0 51 N and longitude 6^0 44 E). The treatment was a factorial combination of "egusi" melon cultivars ("paragi" and "ofe") and three harvesting stages (23, 33, 43 days after anthesis (DAA)). Twenty-five seeds from each treatment were placed on filter paper moistened with distilled water in a petri dish and arranged in a completely randomized design (CRD) with four replicates. Data were collected on 100-seeds weight, number of seeds per fruit, dry seed weight, seed length, seed diameter and germination percentage. The seed moisture content was determined as follows: $\frac{\text{Weight of wet seeds – weight of oven dried seeds}}{\text{Weight of wet seed}} \text{ x } 100$ Germination test were done by counting four replicates of 25 seeds each of the treatment combinations which were placed on filter paper. The Petri-dishes were carefully arranged in seed germination chamber at a constant temperature of 30 ^{o}C. Germination counts were taken every-other-day and results were expressed in percentages. Data collected were subjected to analysis of variance (ANOVA) using Minitab and means were separated using Tukey test at 5 % level of probability where significant differences exists among the treatments.

RESULTS

Table 1 shows the effects of harvesting at different days after anthesis on seed parameters of two "egusi" melon cultivars. The "Paragi" cultivar recorded significantly higher values for all the observed seed parameters except seed length and seed diameter. Also, 23 days after anthesis had significantly lower values compared to 33 and 43 days after anthesis for 100-seed weight, number of seeds per fruit and weight of seed. For seed length and seed diameter, 43 days after anthesis was significantly higher. The interaction effect of "egusi" melon cultivars and harvesting at different days after anthesis was significant at 100-seed weight, highly significant for both number of seeds per fruit and dry seed weight, but not significant for both seed length and seed diameter. The interaction effect of cultivars and harvesting at different days after anthesis were revealed in Table 2. There was a significantly low values of harvesting at 23 days after anthesis compared to 33 and 43 days after anthesis at all the seed parameters irrespective of the cultivar. At each seed parameter, the trend in the values of harvesting at different days after anthesis protocol varied with cultivar. At 100-seed weight, whereas the values for "Paragi" cultivar were not significant in harvesting at 33 and 43 days after anthesis, significant variations were recorded for values with "Ofe" cultivar. At this latter cultivar, the best value was recorded at harvesting at 43 days after anthesis (10.20g). The poorest value was obtained at 23 days after anthesis in "Paragi" cultivar. Variations in responses and trends of values among harvesting at different days after anthesis was recorded at the other seed quality parameters as well. Table 3 shows the effects of harvesting at different days after anthesis on germination percentage on "egusi" melon cultivars at different storage periods. The germination percentage between the two cultivars were generally similar throughout the duration of storage. Though significant germination percentage differences were recorded among the seeds harvested at different harvesting days after anthesis at 0, 6, 8, 10, 12 and 14 storage periods, the trend was not consistent. Furthermore, the interaction between cultivars and harvesting at different days after anthesis was not significant throughout the duration of storage (Table 3

Table 1. Effects of harvesting at different days after anthesis on seed parameters of two "Egusi" melon cultivars

Treatments	100-seed weight (g)	Number of seeds per fruit	Dry seed weight (g)	Seed length (cm)	Seed diameter (cm)
Cultivars (C)					
"Paragi"	10.24a	191a	16.21a	1.06a	0.44a
"Ofe"	9.46b	112b	12.41b	1.03a	0.43a
LSD	0.17	10.85	1.31	0.09	0.05
Days after anthesis (D)					
23	8.93b	108b	13.91b	0.91c	0.29b
33	10.18a	172a	19.11a	1.04b	0.49b
43	10.43a	175a	19.90a	1.20a	0.53a
LSD	0.21	13.29	1.61	6.10	0.06
Interaction					
C x D	*	**	**	NS	NS

LSD = Least Significant Different at 5% level of probability; * = significant; ** = highly significant; NS = not significant

Table 2. Interaction effects of harvesting at different days after anthesis and "Egusi" melon cultivars on 100-seed weight, number of seeds per fruit and weight of seed

Cultivars	Days after anthesis	100-seed weight (g)	Number of seeds per fruit	Dry seed weight (g)
"Paragi"	23	9.46c	112b	13.91b
	33	10.60a	232a	23.34a
	43	10.67a	229a	24.38a
"Ofe"	23	8.44d	103b	6.91c
	33	9.76bc	112b	14.90b
	43	10.20ab	121.b	9.64c
LSD		0.49	30.97	3.75

Table 3. Effects of harvesting at different days after anthesis on germination percentage of two "egusi" melon cultivars at different storage periods

Storage period (weeks)								
Treatment	0	2	4	6	8	10	12	14
Cultivars (C)								
"Paragi"	88.33a	93.00a	95.33a	83.33a	78.00a	64.00a	68.00a	65.33a
"Ofe"	86.50a	94.67a	94.00a	82.00a	78.67a	71.08a	67.75a	61.33a
LSD	7.49	4.87	2.80	7.96	10.08	11.44	` 9.20	13.47
Days after anthesis (D)								
23	79.00b	91.50a	90.00a	73.00b	70.50b	62.50b	59.00b	49.00b
33	92.00a	95.50a	97.00a	90.50a	81.00a	63.50ab	70.13ab	49.00ab
43	91.25a	94.50a	97.00a	84.50a	83.50ab	76.63a	74.50a	73.50a
LSD	9.17	5.92	3.43	9.75	12.35	14.01	11.27	16.50
Interaction								
C x D	NS	NS	NS	NS	NS	NS	NS	NS

LSD = Least Significant Different at 5% level of probability; NS = not significant

DISCUSSION

The "egusi" melon, when harvested at 23 days after anthesis, revealed that the seed still had the high moisture content which greatly impact on the storability but progress in maturity and storability were found in harvesting at 43 days after anthesis. This was similar to the results reported by Demir and Ernis (2005) who had hypothesized that the reduction in the storability might be due to maturity associated issues with development of seeds such as accumulation of dry matters, desiccation development cessation of mobilization. In addition, the higher the moisture content at harvest, the lower the germination percentage was alluded to by Owolade *et al*. (2003) who also observed that the higher the moisture content the higher the loss of seed at storage. It is important to note that the superiority of seeds harvested at 43 days after anthesis was particularly more obvious in age and at the seed quality.

CONCLUSION

It is concluded that seeds of the two cultivars used in this study possessed seed quality potentials but "Paragi" cultivar germinated and stored better than "Ofe" cultivar in few cases. The study also revealed that it may be necessary to immediately record the day of anthesis in "egusi" melon production. Seeds of "egusi" melon harvested at 43 days after anthesis retained higher germination for longer period and exhibited good seed quality. It is therefore recommended that "Paragi' cultivar be nominated for evaluation trials for subsequent release as "egusi" melon variety in Nigeria. Also, that harvesting of "egusi" melon at 43 days after anthesis be adopted in order to enhance good seed quality.

REFERENCES

Bande, Y. M., N. M. Adam, Y. Azmi and O. Jamarei, (2012). Moisture-dependent physical and compression properties of Bitter Melon (*Citrullus Colocynthis Lanatus*) seeds. Int. J. Agric. Res., 7, 243-254.

Bello, E. J. Makande T. (2011) performance evaluation of ``egusi`` mellon (*citrullus colegthos*) seed. *Oil Biodiesel International Journal of Agricultural Research*, 2(5), 741 – 745

Demir, I., Balkaya, A. (2005). Seed development stages of kale (*Brassica oleracea* var.*acephala* L.) genotypes in Turkey. *Horticultural Science*, 32, 147- 153.

Borroso, N. D. S, DE, Souza, M. O., Rodrigue. L. C. D. S and Pelacani, C. R. (2017). Maturation stages of fruits and psychological seed quality of *Physalis ixacarpa* brot. Ex Hormen. *Rev. Bras. Frutic*., 39(3); 1-9

Davison, K. (2013). Response of watermelon, 6 levels of Nitrogen ,Phosphorus, Potassium fertilizer application in yam rotation. International Journal of substainable crop production. 23(4), 127-130

Gbonna P. E., Obi I. U. (2010). Aspects of reproductive character of egusi melon. Proceedings of the 34th annual conference of genetics society of Nigeria, 22-27.

Van der Vossen -Tahir I. M. (2004). *Citrullus lanatus* (Thumb); Matsum and Nakai. In: Grubben, G.J.H. and Denton, O.A. (eds). Plant Resources of Tropical Africa 2. Vegetables. PROTA Foundation, Wageningen. The Netherlands

Ogbonna, Peter Ejimofor (2013), "Floral habits and seed production characteristics in "Egusi" melon (*Colocynthis citrullus* L.)," Journal of Plant Breeding and Crop, Vol 5, issue 6, pp. 137-140

Passam, C. H., Makrogianni, C., Gregoriou, F. & Karapanos, I. C. (1992).The size and germination of eggplant seed in relation to fruit maturity at harvest, after-ripening and ethylene application. Analele Universităţii din Oradea. *Fascicula Biologie*, XVII(2) 225- 229.

84 GRAIN YIELD OF EARLY MATURING PRO-VITAMIN A (PVA) MAIZE INBRED LINES UNDER STRIGA INFESTATION AND OPTIMAL CONDITIONS

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Abstract

A total of two hundred and ten single-cross hybrids generated by crossing the panel of 50 selected early maturing pro vitamin A (PVA) inbred lines from the International Institute of Tropical Agriculture – Maize Improvement Program (IITA-MIP) to four early maturing PVA inbred testers using the line x tester mating design, six single crosses were obtained by intermating the four testers, plus four commercial checks served as the entries. The research was conducted at Mokwa, Niger State for two years under artificial Striga infested and optimal growing conditions. The results revealed that General (GCA) and Specific (SCA) combining ability means were significant (p<0.01) for grain yield and other agronomic traits across environments, this indicated additive and nonadditive gene actions were important in the inheritance of most traits of the inbred lines. The GCA effects of multiple traits (HGCAMT) method classified the inbred lines into four heterotic groups under Striga infestation and five groups under optimal growing condition. TZEIOR 172 x TZEIOR 108 and TZEIOR 202 x TZEI 25 were identified as the highest-yielding and most stable hybrids across the contrasting environments. TZEIOR 21 x TZEI 25 was identified as the preferred hybrid for Striga infested environments. The inbred lines such as TZEIOR 201 and TZEIOR 202 recorded significant and positive GCA effects for grain yield across the contrasting environments and could be useful for developing Striga tolerant and/or combined drought and heat stress tolerant hybrids and synthetics.

Key words: Maize; General combining ability, Specific combining ability, *Striga hermonthica*; inbred lines

INTRODUCTION

Maize (Zea mays L.) is the most extensively grown crop species in the world next to wheat and rice (Maria *et al*., 2017). However, its production and productivity are mostly constrained by *Striga hermonthica* (Del.) Benth., commonly known as *Striga*. *Striga* infestation causes yield losses up to 100 %, which amounts to estimated annual losses of $40.8 million (Kanampiu *et al.*, 2002). *Striga* germination is close to its host in response to specific chemical signals from the root of the host or certain non-host plants (Hooper *et al.*, 2009). The parasitic weed *Striga hermonthica* Benth, is an important constraint to cereal production in sub-Saharan Africa (SSA), often results in yield loss as high as 100 % in maize production and productivity depending on, soil degradation, the severity of the infestation, genotype type, soil fertility, the climatic condition causing farmers to abandon their farmlands. Therefore, there is a need to identify, characterize and commercialize new maize plant varieties possessing the required ecological chemistry to protect crops against this biotic stress of *Striga* under such conditions. *Striga* control complication results in its abundant seed production, a complicated parasitism mode and longevity of the seed bank. One of the effective ways to manage *Striga* is the use of forage legumes as an intercrop. However, the most effective way is development improvement and commercialization of improved crop varieties with resistance to *Striga* for the resource-poor farmers. *Striga* resistance means the capability of the maize plant to suppress the germination and attachment of the *Striga* plants resulting in few numbers of emerged *Striga* plants while *Striga* tolerance is the capacity of the maize plant to survive and produce a reasonable yield in the presence of the attached *Striga* plants (Kim, 1994). Therefore, the objectives of the study were to develop early maturing provitamin A (PVA) single cross hybrids with resistance to *Striga* infestation and identify high yielding and yield stability of the hybrids across environments.

MATERIALS AND METHODS

A total of two hundred and fifty-six early maturing PVA, PVA-QPM inbred lines comprising normal yellow and orange endosperms, extracted from *Striga* resistant and drought tolerant, broad-based population, 2009 TZEOR1 DT STR $S_{7,}$ 2009 TZEOR2 DT STR QPM $S_{7,}$ (TZEI 17×TZEI 11) $S_{6,}$ TZE Comp5-Y C_6 $S_{7,}$ (TZEI 11×TZEI 8) $S_{7,}$ (ENT 8×TZEI 158), TZE-Y-Pop-DT-STR-QPM and 2009-TZE - OR2 DT-STR QPM developed by the IITA-MIP. The 256 inbred lines and 210 single cross hybrids were evaluated at Mokwa (9°18'N and 5°04'E, 457 m asl, 1,100 mm annual rainfall and ferrisol plinthustalf soil type), Niger State Nigeria, under *Striga* infested and *Striga* free conditions. Fertilizer was applied at the rate of 60 kg N ha^{-1}, 60 kg P_2O_5 ha^{-1} and 60 kg K_2O ha^{-1} at 2 weeks after planting (WAP) and an additional 60 kg N ha^{-1} at 4 WAP under *Striga* free condition. Under *Striga* infested condition, about 2WAP, ethylene gas was injected into the soil to stimulate suicidal germination of existing *Striga* seeds in the soil. Fertilizer application of *Striga* plots were delayed until about 21 days after planting when 30 kg ha^{-1} N, 30 kg ha^{-1} P, and 30 kg ha^{-1} K was applied as 15-15-15 NPK. The delay in fertilization was to stimulate the production of strigalactones, which stimulate *Striga* emergence and attachment to the roots of the maize plants. Weeds other than *Striga* in the trials were controlled manually (hand weeding). The hybrid trials were laid out using a 14 x 15 randomized incomplete block design with two replicates and a 16 × 16 randomized incomplete block design with two replicates was used for the inbred line evaluations. Single-row plots, 3 m long, with a spacing of 0.75 m between two adjacent rows and 0.40 m between plants within rows were used for both the inbred line and hybrid evaluations. Three seeds were sown per planting hole and the emerged seedlings thinned to two per stand at 2 weeks after emergence, resulting in a final plant population density of about 66,667 plants ha^{-1}.

DATA COLLECTION

Observations were made on days to 50 % silking (DS) as the number of days when 50 % of the plants had emerged silks, while days to 50 % anthesis (DA) represented the number of days when 50 % of plants had shed pollen. The anthesis–silking interval (ASI) was determined as the difference between DA and DS. Other measured traits were plant height (PLHT) and ear height (EHT), measured as the distance in centimeters between the base of the plant and the first tassel branch and the top ear, respectively. Ears per plant (EPP) was obtained by dividing the number of ears harvested by the number of plants at harvest. Plant aspect (PASP) was rated on a scale of 1–9, where 1 = excellent and 9 = poor; and ear aspect (EASP) was recorded on a scale of 1–9, where 1 = clean, uniform, large, and well-filled ears and 9 = ears with undesirable features, such as diseased, small ears, and ears with poorly filled grains. Data on the number of emerged *Striga* plants and host plant damage (*Striga* damage rating) were collected at 8 and 10 weeks after planting. *Striga* emergence count: the number of emerged *Striga* plants per plot at 8 and 10 WAP; *Striga* damage symptoms rated on a scale of 1 to 9 as described by (Kim, 1994), 1= Normal plant growth, no visible symptoms, 9= Complete scorching of all leaves, causing premature death or collapse of host plant and no ear formation. Grain yield ($kgha^{-1}$) of the rainfed experiment was computed on the basis of the field weight, assuming a shelling percentage of 80 at 15 % moisture content. Grain yield under *Striga*-infested environment was calculated as follows:

$$Grain\ yield\ \left({}^{kg}/_{ha}\right) = field\ weight\ \left({}^{kg}/_{plot}\right)\ X\ \frac{(100 - moisture)}{85}\ X\ \frac{10000}{4\ X\ 0.75}\ X\ \frac{80}{100}$$

Where: 10,000= land area per hectare (m^2), 4x0.75= land area per plot (0.75 m x 0.4 m), and 0.80 = 80 % shelling percentage.

STATISTICAL ANALYSIS

Log transformation as performed on data related to counts, scales and scores using the formula [log (counts + 1)], while square roo t transformation was carried out on data in percentages before subjecting them to analysis of variance (ANOVA). Data on grain yield and other agronomic traits were subjected to combined ANOVA for each environment using PROC GLM in Statistical Analysis System (SAS) version 9.3 (SAS Inc. 2011). Analysis of variance were performed on the adjusted means of the individual traits *Striga* infested and optimal growing conditions and thereafter combined across environments.

RESULTS

The combined analysis of variance (ANOVA) across the two *Striga* environments showed highly significant ($P< 0.05$ or $P< 0.01$) differences among environments (E) and entries (inbred lines) for measured traits (Table1). The genotype x environment interactions (GEI) were significant ($P < 0.05$) for measured traits except for anthesis-silking interval (ASI) while significant differences were detected in the environments for all the measured traits. Broad sense heritability (H^2) estimates based on plot mean basis ranged from 42 % for ear height (EHT) to 64 % for ears per plant (EPP), while the estimate for grain yield was 68 %. The H^2 for ASI could not be determined because of the negative genotypic variance. The results also revealed moderately high to high heritability estimates for traits measured under *Striga* infestation. The combined ANOVA across three optimal environments showed significant ($P< 0.05$ or $P< 0.01$) variations among environment, entry (genotype) and genotype x environment mean squares for all measured traits except GEI effects for ears per plant (EPP). Heritability (H^2) estimates ranged from 58 % for ears per plant (EPP) to 80 % for ear aspect (EASP), grain yield had very high estimates of 85 % and EPP 80 % under optimal environments (Table 2).

Table 1: Mean squares and heritability estimates of 256 early maturing PVA, PVA-QPM maize inbred lines evaluated under *Striga* infested condition at Mokwa during the 2019 and 2020 growing seasons

Source	DF	GY ($t\ ha^{-1}$)	DA	DS	ASI	PLHT	EHT	*Striga* rating	damage	*Striga* emergence count		EASP	EPP
								8WAP	10WAP	8WAP	10WAP		
ENV	1	600443359.30**	8841.87**	831.96**	868.41**	362441.60**	6015.94**	1681.00**	83.27*	0.19**	1.01**	243.91**	40.14**
Entry	255	1067995.40**	483.41**	533.29**	3.32*	1684.91**	599.67**	3.51**	6.44**	0.24**	0.25**	6.67**	0.12
Rep(ENV)	2	76139849.20**	54.24**	58.23**	10.34**	2580.10**	1223.76*	12.10**	12.10**	0.10**	0.31**	49.93**	1.37*
BLK(ENV*Rep)	60	798245.20**	11.95**	14.09**	3.12**	677.04**	264.83**	1.30**	2.12**	0.12*	0.10**	5.60**	0.13*
Entry*ENV	255	726600.50**	457.45**	501.42**	3.54	1577.01**	586.37**	3.22**	5.39*	0.20**	0.21**	6.53**	0.09**
Error	450	427852.00	3.30	4.79	1.55	264.30	130.41	0.33	0.97	0.06	0.04	1.25	0.05
Heritability	-	68	50	58	-	56	42	51	48	51	48	69	64

*, ** = Significant. at 0.05 and 0.01 probability. levels, respectively; Env = environment; Rep=replication; GY = Grain yield; DA.= days to 50 % anthesis; DS. = days to 50 % silking; ASI. = anthesis-silking interval; PLHT = plant height; EHT = ear height; EASP. = ear plant aspect; EPP. =ears per plant.

Table 2: Mean squares and heritability of grain yield and other agronomic traits of 256 PVA, PVA-QPM maize inbred lines evaluated under optimal growing environments at Mokwa 2019 and 2020 growing seasons.

SOURCE	DF	YIELD	DA	DS	ASI	PASP	EASP	EPP	PLHT	EHT
Env	1	396743.70**	11.04**	32.19**	638.80**	194.84**	98.79**	0.03**	42147.27**	7538.62*
Entry	255	1620201.60**	10.31**	13.13**	0.72**	2.31**	3.10**	0.11**	367.28**	135.14**
Rep(Env)	2	2799843.50**	860.59**	1148.64**	0.77**	19.65**	10.85**	0.64**	4168.83**	2431.98**
BLK(Env*Rep)	60	846949.30**	11.52**	15.81**	0.50*	1.27**	2.11**	0.10**	328.77*	202.51**
Entry*Env	244	771149.20*	4.86**	6.13**	0.93**	1.56**	2.17**	0.12	260.30**	100.87**
Error	437	481999.80	4.01	4.94	0.59	0.85	1.80	0.09	91.81	67.63
Heritability	-	85	67	72	74	74	80	58	65	74

*, ** = Significant at 0.05 and 0.01 probability levels, respectively; Env = environment; Rep = replication; DA = days to 50 % anthesis; DS = days to 50 % silking; ASI = anthesis-silking interval; PLHT = plant height; EHT = ear height; PASP = plant aspect; EASP = ear plant aspect; EPP = ears per plant.

DISCUSSION

The significant differences observed among measured traits under *Striga* infestation and optimal environments indicated that the germplasm evaluated in this study is genetically diverse which should allow good progress from the selection under contrasting environments. The significant environmental variation for all traits under *Striga* infestation and optimum environments indicated that each environment was unique and highly variable emphasizing the need for testing in more environments over years. The significant genotype x environment interactions for grain yield, *Striga* damage ratings and emerged *Striga* plants under *Striga* infestation is an indication that the hybrids responded differently to *Striga* infestation at the different sites suggesting that the strains of *Striga. hermonthic*a at the different sites were different. The significant genotype x environment interactions for grain yield, *Striga* damage ratings and emerged *Striga* plants under *Striga* infestation is an indication that the hybrids responded differently to *Striga* infestation at the different sites suggesting that the strains of *S. hermonthic*a at the different sites were different. Similar findings were reported by several researchers in West and Central Africa (Yallou *et al.*, 2009; Menkir *et al.*, 2010; Badu-Apraku and Lum, 2010; Badu-Apraku *et al.*, 2019).

CONCLUSION

The Savanna agro-ecologies of West and Central Africa (WCA) have the highest potential for maize grain yield production and productivity due to low night temperatures, low incidence of pests and diseases and high solar radiation, all of which favour maize production and productivity. However, *Striga hermonthica* parasitism, declining soil fertility and drought stress are the major limiting factors to maize production in the subregion. Genetic enhancement of maize under *Striga hermonthica* could improve grain yield for farmers.

RECOMMENDATION

The two highest yielding and most stable hybrids (TZEIOR 172 x TZEIOR 108) and (TZEIOR 202 x TZEI 25) should be tested in multi-location trials to confirm the consistency of performance and promoted for adoption and commercialization in the sub-region.

REFERENCES

Badu-Apraku, B., Lum, A. F., (2010). Improvement of yield and other traits of extra-early maize under stress and nonstress environments. Agronomy journal, 101(2), 381-389.

Badu-Apraku, B., Ifie, B.E., Talabi, A.O., Obeng-Bio, E., & Asiedu., R. (2019). Genetic variances and heritabilities of traits of an early yellow maize population after cycles of improvement for Striga resistance and drought tolerance. Crop Science, 58, 1–13.

Hooper, A.M., Hassanali, A., Chamberlain, K., Khan, Z.R., Pickett, J.A., (2009). New genetic opportunities from legume intercrops for controlling Striga spp. Parasitic weeds. Pest Manage. Sci. 65, 546e552

Kanampiu, F., Friesen, D., Gressel, J., (2002). CIMMYT unveils herbicide-coated maize seed technology for Striga control. Haustorium 42, 1e3.

Kim, S. K. (1994). Genetics of maize tolerance to Striga hermonthica. Crop Science, 34, 900–907. https://doi.org/10.2135/cropsci1994. 0011183x003400040012x

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Menkir, A., Adetimirin, V. O., Yallou, C. G., & Gedil, M. (2010). Relationship of genetic diversity of inbred lines with different reactions to Striga hermonthica (Del.) Benth and the performance of their crosses. Crop Science, 50, 602-611.

SAS Institute. 2011. SAS Proprietary software Release 6.12. SAS Institute, Inc., carry, NC.

Yallou, C. G., Menkir, A., Adetimirin, V. O., & Kling, J. G. (2009). Combining ability of maize inbred lines containing genes from Zea diploperennis for resistance to Striga hermonthica (Del.) Benth. Plant Breeding, 128, 143-148.

85 EFFECTS OF LOCATION OF SEED IN FRUIT ON SEED QUALITY OF OKRA (*Abelmoschus esculentus* (L.) Moench)

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Abstract
The experiment was carried out at the Crop Production Department Laboratory, Federal University of Technology, Minna Niger State, Nigeria. Field work for seed multiplication was done at the research farm of Crop Production Department during the raining season of 2019. Two plots of land (plot 1 and 2) measuring 15m by 26m each were prepared for the mass production of seeds of LD88 okra varieties Treatments were locations (base, middle and top) replicated four times and fitted into a Completely Randomized Design (CRD). Sample of seeds of each of the different treatments was placed in an open plastic plate measuring 300 mL. The containers were placed in the incubator at a temperature of 37 ^{0}C. Data were collected on number of seed per fruit, seed yield, seed moisture content, 100-seed weight, germination percentage, germination speed and electrical conductivity of the seeds. Data collected were subjected to analysis of variance (ANOVA) and means were separated using Duncan Multiple Rang Test (DMRT). The results showed that significantly higher ($p<0.05$) number of seeds and seed yield were recorded at middle and top over the base. The base had a significantly heaviest ($p<0.05$)100-seed weight, followed by the middle while the top had the least value.. Germination percentage was generally best at the base and middle locations. The top seeds had the highest leachate. Germination speed was insignificantly similar in the three locations

Keywords: Anthesis, viability, leachates.

INTRODUCTION

One of the most popular vegetables consumed across Nigeria is okra (Johnson, 2017). Okra (*Abelmoschusesculentus (L) Moench*), belongs to the family "Malvaceae". The crop originated from Ethiopia (Sathish and Eswar., 2013) but spread to other countries through the Portuguese..Okra is one of the most widely known and utilized species of the family "Malvaceae" (Naveed *et al*., 2009). It is grown as a fruit vegetable on almost all West African farms and high values are attached to its edible green pods, leaves and seeds. The tender leaves of okra are chopped together with the fruits for making soup. The fruits are used either in the green or dried form. It may be chopped green and cooked as soup to accompany dish or sliced, dried and ground into powder for future use (Ibrahim and Oladiran,2011). The matured stem contains fibre of good strength and is used for domestic purposes which include making of fish line, traps and hammocks. The edible parts are the cheapest source of essential minerals like iron, phosphorus, and calcium.

They are also sources of iodine which prevent the development of goitre in people whose drinking water is deficient of the mineral. Numerous small-holder farmers (who produce the bulk of the crops in circulation) still hold on to the practices of leaving okra fruits at various positions on mother-plant until all the fruits are mature and completely dried before they are harvested at the end of the season; seeds from such fruits are extracted and bulked irrespective of the position of the seeds within the fruit/pod. It therefore means that farmers take no account of the differences in quality that may exist among seeds in the various locations within the fruit It is believed that the bulked seed lot might have varied qualities brought about by the differences in the positions/location of seeds within the fruits.It is clear that population at present increases in geometrical progression while the accessible land to produce food for the exploded human population is limited in supply. Although, there are various ways of carrying out soil improvement to increase crop productivity, wrong choice of seeds will definitely make no meaning out of the planned programme. Hence, good quality seeds (in terms of higher germination /emergence rate and increase in vigour) will definitely complete the race towards achieving food sufficiency. Therefore, the objective of the study was to examine the effects of differences in locations of seeds in fruits on seed quality.

MATERIALS AND METHODS

This study was carried out at the Teaching and Research Farm of Federal University of Technology, Minna (Latitude 9^{o} 31^{1} N and Longitude 6^{o} 29^{I}E) during the raining season of 2019. Seed quality studies were carried out in the laboratory of Crop Production Department, Federal University of Technology, Minna.

LD88 variety of okra was obtained from the National Horticultural Research Institute (NIHORT), Ibadan Nigeria.Mass planting technique was adopted to produce adequate seeds for seed parameters studies. A plots of land which measured 15m by 26 m was prepared for the mass production of seeds of LDD88 varieties of okra. The plots of land was cleared, ploughed and narrow ridges (0.40m wide) of 15m in length were constructed manually (using hoes) at a spacing of 0.75m apart. Seeds of the variety LD88 were sown at a spacing of 50 cm along the ridges. Two seeds were sown per hole and seedlings were later thinned to one per stand after two weeks of sowing. Weeding was done manually using hoes at interval of two weeks from the day of crops emergence from the soil to keep the field weed free. Flowers were date-tagged at various positions as they opened to index anthesis; ensuring easy identification of fruit age. Fruits that developed from tagged flowers were harvested at 42 Days After Anthesis (DAA) when the initial green colour of the fruits had turned straw brown and the fruits completely split along the ridges. The treatments comprised of location (base, middle and top) replicated four times and fitted into a Completely Randomized Design (CRD).Freshly harvested fruits were immediately taken to the laboratory of Crop Production for further studies. Each fruit from each replicate was divided into three equal parts (Base, Middle and Top). Each part of the fruit was then opened and seeds extracted were counted (to determine seed number) and weighed fresh (to determine seed yield) before shade-drying for two weeks on top of paper placed on the table in the laboratory. Data were collected based on number of seeds, seed yield, seed moisture content, 100-seed weight, germination percentage (GP), germination speed (GS) and electrical conductivity (EC) test. All data collected were subjected to analysis of variance (ANOVA) using Statistical Analysis System (SAS) package; version: 2017 7.0. Means were separated using Duncan Multiple Range Test (DMRT) at 5 % level of probability.

RESULTS AND DISCUSSION

Location of seeds in fruit significantly *($p<0.05$)* affected all seed parameters measured as shown in Table 1. The number of seeds were significantly higher at middle (45.41) than the top (43.09); but lowest at the base (22.41). Similarly, seed yield was significantly lowest at the base(1.12), higher *($p<0.05$)* at the middle but highest *($p<0.05$)* at top (2.14). The significantly high number of seeds recorded at middle and top over the base is as a result of more flesh (nutrient transporting tissues) which normally accumulate at the base of the fruit leaving less space for seeds while the ‘middle’ and ‘top’ have more space for the formation of more seeds due to lesser flesh. This was clearly noticed in the study during the process of seed extraction. This is also connected to the higher seed yields observed at the ‘middle’ and ‘top’. Carol *et al.*, (2011) revealed that numerous nutrient transporters occupy the base of the pod and they control the importation of nutrient elements into the seed.

100-seed weight was significantly highest*($p<0.05$)* at the base (4.54), followed by those at the middle (4.30) but significantly lowest*($p<0.05$)* at the top (4.11). The highest value observed at the base is traced to the fact that more nutrients get to the basal seeds since they are closest to the environment of higher concentration of macronutrients than the top; hence, bigger and heavier seeds due to more dry matter (assimilates) deposited in the basal seeds than the middle and lesser at the top. (Kolodziejek 2017) observed in *Peucedanum oreoselinum* (Apiaceae), that high quantity of macronutrient in surrounding of the fruit often lead to the production of seeds that are heavier. So, the abundant nutrient transporters that fill the base of the pod (Carol *et al.*, 2011) will likely increase the amount of assimilates available to the basal seeds; but, least at the top.

Table 1 : Effects of location of seed in fruit on seed parameters of LD88 variety of okra

Treatments	Number of seeds	Seed yield (g)	Seed moisture content (%)	100-seed weight (g)
Base	22.00c	1.12c	18.46a	4.54a
Middle	45.00a	2.12b	18.43a	4.30b
Top	43.00b	2.14a	17.24a	4.11c
SE±	0.32	0.014	3.25	0.01
LSD	0.63	0.01	86.21	0.01

Means with the same letter in the same column are not significantly different at (P<0.05) level of probability

Location of seed in fruit significantly (P<0.05) affected the germination percentage as indicated in Table 2 . The base had a significantly highest (P<0.05) germination percentage after the followed by the middle but lowest at the top. The best and better germination percentage values associated with the base and middle respectively are traced to greater dry matter accumulation which can likely give the seeds upper hand over the top seeds.Location of seeds in fruit insignificantly affected germination speed among the 'base', 'middle' and 'top' seeds. Germination speed were statistically similar as evident in table 2.

Location of seed in fruit significantly (P<0.05) affected the electrical conductivity of seed as it is observed on table 2.The 'top' seeds had a significantly highest (P<0.05) leachate than those from the 'base' and 'middle'. This suggests that the top seeds were of lesser quality than the basal and middle seeds right from the time of harvest. .Kennya, *et al.*,(2012) explained that electrical conductivity is based on the principle that low conductivity (lower output seed leachate) means a high-quality seed while high-conductivity references greater output seed leachate, suggesting lesser quality

Table 2: Effects of location of seed in fruit on the germination percentage, germination speed and electrical conductivity of seeds of LD88 variety of okra

Treatments	Germination percentage	Germination speed (days)	E C Test (ms/cm
Base	69.63a	3.87a	247.26b
Middle	67.70b	4.00a	234.36c
top	64.70c	4.00a	269.57a
SE±	0.33	0.35	3.18
LSD	0.67	0.69	6.33

Means with the same letters in the same column are not significantly different at ($P<0.05$) level of probability

CONCLUSION

Considering the results of this research work carried out using the LD88 varieties of okra, the conclusion can be drawn based on the fact that seed-filling was greater in seeds extracted from the base and middle part of the fruit than those from top locations of the fruit. This was clearly observed from the 100-seed weight where the basal and middle seeds had significantly higher values than those from the top. In addition, germination percentage significantly favoured the basal and middle seeds than those from the top location of the fruit. Electrical conductivity values of the seeds also indicated lesser quality of the top seeds than those from the base and middle. It is therefore recommended that the extraction of okra seeds to be sown as the next season cropping should be restricted to the base and middle location of the pod for better viability and vigour.

REFERENCES

Carol, W., Emma J. B. and Jeremy, A. R (2011). The role of the pod in seed development: trategies for manipulating yield. Agricultural Biotechnology https://doi.org/10.1111/j.1469-8137.2011.03714.x

Ibrahim, H., and Oladiran, J. A. (2011). Effect of fruit age and position on mother-plant on fruit growth and seed quality in okra (*Abelmoschus esculentus* L. Moench). *InternationaJournal of Science and Nature* Vol. 2(3): 587 – 592.

Kennya, M. O., Ramos, J. M.,.Matos, M. R., Martins, C.C and Ildeu S. M(2012).Electrical conductivity testing as applied to the assessment of freshly collected *Kielmeyera coriacea* Mart. seeds", *International Scholarly Research Notices*, vol. 2012, Article ID 378139, 5 pages. https://doi.org/10.5402/2012/378139

Kołodziejek, J. (2017). Effect of seed position and soil nutrients on seed mass, germination and seedling growth in *Peucedanum oreoselinum* (Apiaceae). *Scientific Report* 7,1959 (2017). https://doi.org/10.1038/s41598-017-02035-1

Naveed, A., A.A. Khan and I.A. Khan, (2009). Generation mean analysis of water stress tolerance in okra *(Abelmoschousesculentus*(L.) Moench). *Pakistan Journal of Botany,* 41: 195-205.

Sathish, D., and Eswar, A. (2013). A Review on: *Abelmoschus esculentus* ("Okra"). *International Resources Journals of Pharmaceutical and Applied Sciences,* 3(4):129-132.

86 MORPHOLOGICAL AND SEEDS DIVERSITY IN DRUMSTICK PLANT (*Moringa oleifera* Lam.) GERMPLASM FROM NORTHERN NIGERIA

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Abstract

Genetic diversity within and among accessions of Moringa oleifera in Northern Nigeria was evaluated to determine the level of variability its exploiting in breeding and genetic improvement programs of plant. Collection and characterisation of the crop germplasm from the major cultivated states in Nigeria was carried. Evaluted for morphological was done using a Randomised Complete Block Design (RCBD) with replicate three each. A total of 34 accessions were collected with high significant (P < 0.05) variability observed in seed length, days to emergence, plant height and number of branches per plant. The seed length ranged from 1.02 cm to 1.44 cm while days to emergence varied from 5.00 to 10.00 days. The highest plant height and number of branches per plant were recorded in NGR-ZFR-16 at 2 month after emergence with the value of 94.87cm and 18.00 branches per plant. These highest values recorded in the accession was maintained in subsequent months signifying the superiority of the accession. Cluster analysis grouped the accessions into three major clusters based on their morphological similarity; three major groups, with cluster I consist 55.88% of the genotypes, 38.23% in cluster II, 5.88% in cluster III. The high variability recorded in the germplasm, indicate that the accessions and traits could be explored in the crop improvement.

Keywords: Crop improvement, Germplasm, Genetic variability, *Moringa oleifera*, Landraces,

Introduction

Moringa oleifera, also known as Drumstick tree, is a perennial flowering plant of the family Moringaceae, (Abdellatef and Khalafalla, 2010). It is cultivated in tropical regions and all over the world due to high protein, vitamins, mineral and carbohydrate content of entire edible parts of the plant; leaves, pod, stem and root (Ojuederie *et al*., 2013; Amao *et al*., 2017). *M. oleifera* play an important role in dietary diversification and contribute to relief of hidden hunger in less developed and developing countries like Nigeria (Popoola and Obembe, 2013). In the northern parts of Nigeria where it is locally called Zogale among the Hausa speaking people, it is one of the vegetable which is fast gaining wide acceptance and cultivated. However, the plant is considered as is neglected and underutilized vegetable probably due to loss of local knowledge and lack of established varietiess with little or no research attention from agronomic researchers (Padulosi *et al*., 2013).

Understanding knowledge of genetic diversity has been reported to be one of the prerequisites for development of plant species conservation strategies (Rao and Hodgkin, 2002). Exploitation of the variability through germplasm evaluation and characterisation studies for key traits are essential not only for understanding the breeding value of the indigenous clandraces but also for isolating promising germplasm lines which could be used for the crop improvement (Abubakar *et al*., 2019). Thus, study on the nature and magnitude of the diversity in existing germplasm of drumstick *(M. oleif*era) in Northern Nigeria would enable the identification of accessions with superior characteristics for selection which could be used in further breeding program.

Materials and Methods

Source of experimental materials

Seeds of *Moringa oleifera* were collected from 10 cultivated states in Northern Nigeria. Farmers' fields and the local markets were visited for the collection of the germplasm. These accessions covered the accessible growing state (Bauchi, Benue, Jigawa, Kaduna, Kano, Nasarawa, Niger, Sokoto, Zamfara and FCT) in the Northern Nigeria. Mode of collections and geographical distribution were carried out as described by Popoola and Obembe (2013).

The accessions were evaluated for quantitative parameters using a Randomised Complete Block Design (RCBD) with each accession replicated three times. A total of 3 seeds per poly pot were sown for each accession at a spacing of 100 cm for both inter and intra rows. The seedlings were thinned to one plants per stand and transplanted on the field at four weeks after emergence. Weeding was done manually using hoe when necessary.

Data collection and analysis

Data were collected on quantitative traits base on standard procedures. Quantitative data such as seed length (SDD), day to emergence (DTA), plant height (PLH) and number of branches per plant (NBPP). Data collected on quantitative characters were subjected to analysis of variance (ANOVA) using the statistical package for social sciences, version 2020. Also, the quantitative characters were used for construction of dendrogram.

Results

Morphological characterisation of the accessions showed that there were significant differences among the accessions at different time of the study period with different traits favouring different accessions. Seed length varied from 1.02 cm in NGR-YOB-31 to 1.44 cm in both NGR-ZFR-14 and NGR-KAD-17. These values were differed significantly from one another and from the value of all other accession. Significant earlies day to seedling emergence was 5.00 days obtained in

NGR-BCH-11, NGR-ZFR-15 and NGR-ZFR-16, while the latest was 10.00 days in NGR-BEN-28 and NGR-SOK-33. These values were differed significantly from the value of all other accession. At two and six months after emergence (MAE), the highest plant were obtained from NGR-ZFR-16 (94.87 and 277.27) cm and followed by NGR-ZFR-15 (91.50 and 273.23) cm. These plants heights two MAE were not significantly different ($p > 0.05$) from one another but differed significantly from the height of all other accessions (Table 1.). The least plant height was recorded in NGR-SOK-33 during the study with the values of 57.00, 105.77 and 167.40cm at 2, 4 and 6 MAE, respectively. This value at 6 MAE was not significantly different ($p > 0.05$) from all other accessions value.

The highest number of branches per plant at 2 MAE was recorded in NGR-ZFR-16 (18.00) and the least was obtained in NGR-FCT-07 an NGR-BEN-27 with the average value of 11.67. This highest value was not significantly different from 17.67 branch per plant obtained in both NGR-ZFR-15 and NGR-BCH-12. At 4 and 6 MAE accession NGr-BEN-12 had the highest number of branches per plant with the value of 41.67 and 60.33, respectively (Figure 1). Cluster analysis of the 34 collected accessions based on their similarity distance revealed that there was high diversity among the moringa accessions in terms of the morphological traits, with accessions from different states been clustered in the same group (Figure 2). On the basis of morphological similarity, the accessions were clustered into three major groups, with cluster I consist 55.88% of the genotypes, 38.23% in cluster II, 5.88% in cluster III and 28.57%. Cluster I was further sub-divided into two subgroups (Ia and Ib) with Sub-cluster Ia having accession 11 accessions Ib had 8 accessions. Accession NGR-SOK-33and NGR-BEN-28 were group together as a distinct accession in cluster III (Figure 1).

Table 1: seed length, seed emergence and Plant heights of *Moringa oleifera* germplasm from Northern Nigeria

Parameters	State	Seed Length	Day to Emergence	PLH2	PLH4	PLH6
NGR-NG-01	Niger	1.36±0.02cde	8.00±0.00def	94.47±0.90i	176.4±70.69jkl	254.40±2.08a
NGR-NG-02	Niger	1.34±0.05bcde	6.67±0.33abcd	83.13±0.49ij	170.17±1.30jk	247.40±1.01a
NGR-NG-03	Niger	1.22±0.04abcde	8.67±0.67def	75.43±0.72efg	154.20±1.04fgh	227.70±0.80a
NGR-NG-04	Niger	1.36±0.04cde	6.33±0.23abcd	84.67±0.38ij	165.43±0.38hij	240.97±0.12a
NGR-FCT-05	FCT	1.20±0.05abcde	8.00±0.00def	68.17±0.12d	143.60±0.83def	214.23±1.10a
NGR-FCT-06	FCT	1.20±0.03abcde	7.00±0.00bcd	76.77±0.19gh	168.77±0.28ijk	232.97±0.63a
NGR-FCT-07	FCT	1.18±0.06abcde	7.67±0.33cde	77.33±0.24gh	147.57±0.38efg	221.70±0.87a
NGR-NSR-08	Nasarawa	1.44±0.05cde	8.33±0.33def	75.97±0.61efg	166.70±1.44hij	257.23±1.33a
NGR-NSR-09	Nasarawa	1.38±0.06cde	7.00±0.00bcd	87.47±1.42ij	178.40±1.19kl	267.07±1.61a
NGR-NSR-10	Nasarawa	1.40±0.04cde	7.33±0.19bcde	83.27±1.47ij	171.77±0.90jk	262.77±1.40a
NGR-BCH-11	Bauchi	1.32±0.11bcde	5.00±0.00a	79.60±1.06hi	163.17±0.67hi	251.270.52a
NGR-BCH-12	Bauchi	1.40±0.04cde	5.33±0.33ab	70.27±1.29efg	148.00±1.57efg	253.77±1.33a
NGR-BCH-13	Bauchi	1.38±0.04cde	6.33±0.67abd	60.43±3.20abc	149.40±4.73efg	249.56±5.07a
NGR-ZFR-14	Zamfara	1.44±0.05e	5.67±0.33abc	76.53±1.68gh	168.67±2.34hij	271.87±3.96a
NGR-ZFR-15	Zamfara	1.42±0.04de	5.00±0.00a	91.50±0.96j	186.73±1.41L	273.23±1.79a
NGR-ZFR-16	Zamfara	1.40±0.04cde	5.00±0.00a	94.87±0.18j	177.87±0.62jkl	277.27±1.16a
NGR-KAD-17	Kaduna	1.44±0.06e	8.00±0.00def	79.83±0.63gh	161.50±0.55hi	245.80±0.72a
NGR-KAD-18	Kaduna	1.40±0.07cde	7.33±0.33bcde	77.57±1.84gh	164.53±2.22hi	233.20±1.59a
NGR-KAD-19	Kaduna	1.38±0.04cde	7.67±0.30cde	72.47±0.77def	166.83±1.52hij	227.37±1.43a
NGR-KN-20	Kano	1.06±0.07ab	8.33±0.67def	61.40±1.30abc	152.37±1.84fgh	243.93±2.32a
NGR-KN-21	Kano	1.10±0.05abc	7.33±0.33bcde	74.93±0.59def	142.50±0.93cde	209.53±1.13a
NGR-KN-22	Kano	1.24±0.02abcde	7.33±0.33bcde	61.33±1.88abc	140.37±1.43cd	217.40±2.03a
NGR-JGW-23	Jigawa	1.14±0.06abcde	8.00±0.00def	75.67±0.33efg	140.87±0.07cd	208.67±0.88a
NGR-JGW-24	Jigawa	1.26±0.02abcde	9.33±0.67ef	64.33±2.91c	155.50±2.64gh	233.03±1.70a
NGR-JGW-25	Jigawa	1.22±0.07abcde	9.33±1.33ef	57.77±0.77ab	139.33±0.35cd	221.30±1.01a
NGR-BEN-26	Benue	1.14±0.07abcde	7.33±0.67bcde	72.33±1.29de	136.93±0.61cd	200.47±0.47a
NGR-BEN-27	Benue	1.20±0.04abcde	7.67±0.33cde	62.73±1.50bc	129.13±2.01c	205.47±0.80a
NGR-BEN-28	Benue	1.22±0.02abcde	10.00±0.00f	56.73±2.01a	114.20±3.28b	184.07±3.96a
NGR-YOB-29	Yobe	1.22±0.08abcde	8.33±0.33def	75.20±0.15efg	135.73±0.37c	213.20±0.31a
NGR-YOB-30	Yobe	1.12±0.10abcd	7.67±0.29cde	73.13±0.64def	138.60±0.30cd	217.00±1.00a
NGR-YOB-31	Yobe	1.02±0.06a	8.67±0.33def	76.07±1.21efg	139.40±0.70cd	208.67±1.34a
NGR-SOK-32	Sokoto	1.34±0.05bc	7.67±0.31cde	82.80±0.53ij	154.27±1.83efg	221.60±0.93a
NGR-SOK-33	Sokoto	1.34±0.08bc	10.00±0.00f	57.00±1.35a	105.77±2.51a	167.40±2.19a
NGR-SOK-34	Sokoto	1.24±0.07ac	8.67±0.67def	80.63±0.35hi	140.30±0.21cd	202.90±0.84a

Means followed by similar alphabet letters are not significantly different by Student-Newman-Keuls (SNK). Note: PLH2: plant height at 2 months after emergence; PLH4: plant height at 4 months after emergence, PLH6: plant height at 6 months after emergence

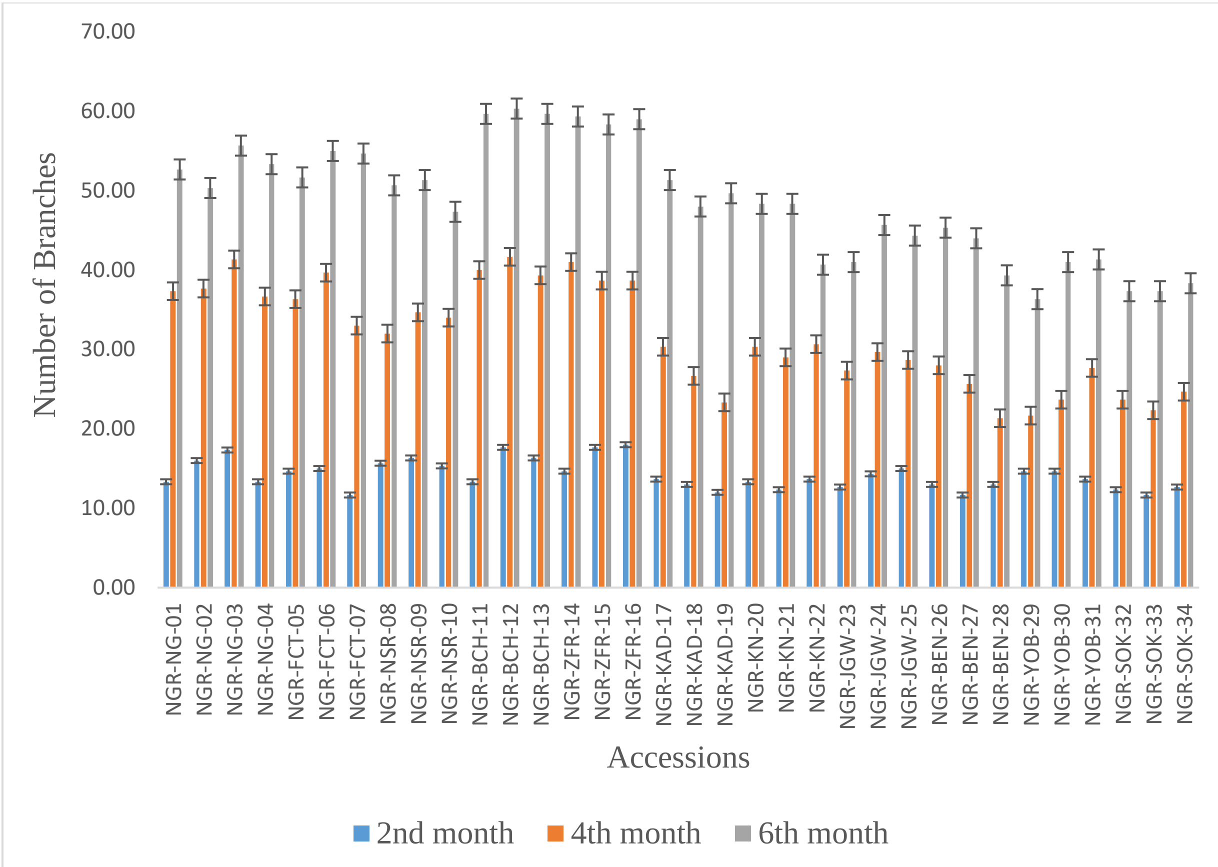

Figure 1: Number of branches per plant of thirty four (34) *Moringa oleifera* accessions from Northern Nigeria.

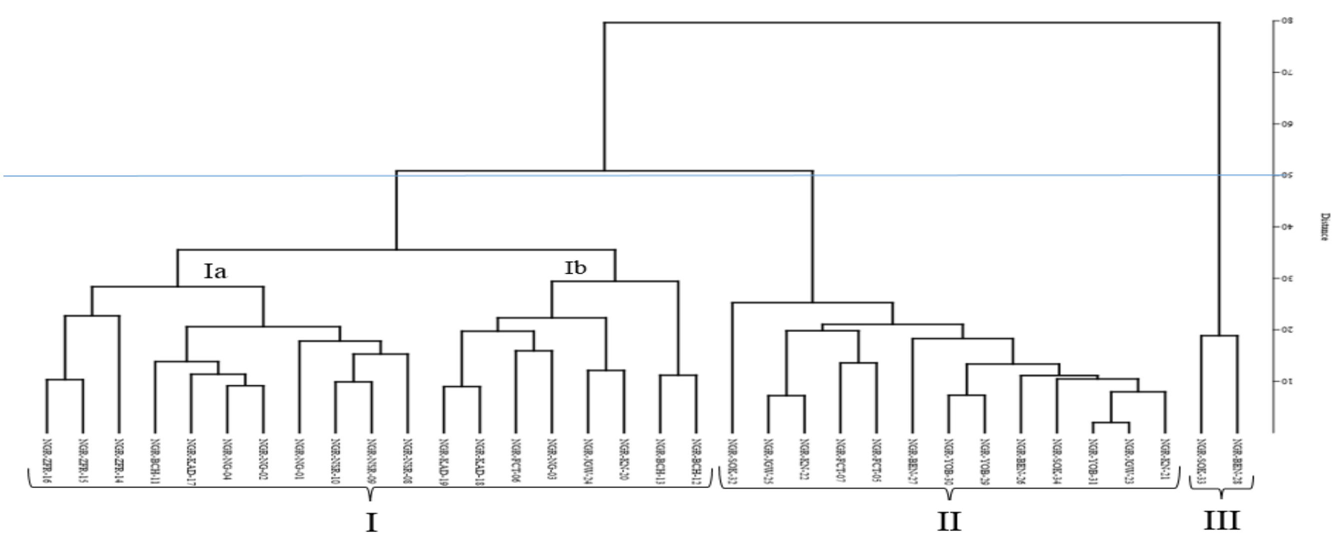

Figure 2: UPGMA dendrogram on morphological traits of 34 *Moringa oleifera* (Lam.) accessions from northern Nigeria.

Discussion

Genetic diversity has been described as the amount of variability among individuals of a variety or population of species resulting from many genetic differences between individuals and may manifest in differences in DNA sequence, in biochemical characteristics like protein structure, in physiological properties like abiotic stress resistance or growth rate, orin morphological characters (Amao *et al*., 2017). The ranged of seed length recorded in this study falled within the ranged of 0.98 and 1.54 cm obtained by Ruiz-Hernández *et al*. (2021), and the average value 1.5 cm reported by Zhigila *et al*. (2015) and 1.16 of López *et al*. (2018). In agreement with 6 to 12 days to emergence reported by Onyekwelu and Olabiwonnu (2010) 5 to 10 days was recorded in the study. The high significant differences recorded in plant height and number of branches among the accessions studied with different accessions been identified as sources for specific traits of interest, demonstrate that adequate variability exist in the germplasm. Similarly, Saini *et al*. (2013) has attributed the diversity in Indian *M. oleifera* cultivars to the spread of the planting material and gene flow in high rates through cross pollination. These variabilities observed could be attributed to the cross-pollination nature of the plant. In line with this results several works have reported high variability in morphology of the plant (Hassanein and Al-Soqee, 2018).

Grouping of the accessions into four clusters with each cluster group containing accessions from different state and source, indicate that there was no association between pattern of clusters and geographical distribution of accessions. Similar to the findings obtained in this study Shahzad *et al.* (2013) suggest that that the grouping of the accessions is an indication of multiple ancestral populations of *M. oleifera* within close geographical regions must have been introduced to other parts of the world.

Conclusion

The study confirmed that considerable high variability exists among the landraces of *M. oleifera* in the country. Clustering of the genotypes independent of the state or source of collection suggested that, hybridizing the genetically diverse parents of the crop belonging to different clusters of could provide an opportunity for bringing genes of diverse nature together for it improvement.

References

Abdellatef, E., & Khalafalla, M.M. (2010). *In-Vitro* morphogenesis studies on *Moringa oleifera* L. an important medicinal tree. *International Journal of Medicobiological Research* 1 (2), 85-89.

Abubakar, A., Falusi, O.A., Adebola, M.O., Olayemi, I.K. & Daudu, O.A.Y. (2019). Genetic diversity studies for morphological traits in pearl millet (*Pennisetum glaucum* L.) landraces of Northern Nigeria. *GSC Biological and Pharmaceutical Sciences*, 2019, 07(02), 060–070

Amao, A.O., Echeckwu, C.A., Aba, D.A., Katung, M.D., & Odeseye A.O. (2017). Diversity study of Drumstick (*Moringa oleifera* Lam.) using microsatellite markers. *International Journal of Environment, Agriculture and Biotechnology*, 2(5), 2380 – 2386. *http://dx.doi.org/10.22161/ijeab/2.5.14*

Hassanein, A.M.A., & Al-Soqeer, A.A. (2018). Morphological and genetic diversity of *Moringa oleifera* and *Moringa peregrina* genotypes. *Horticulture, Environment, and Biotechnology*, https://doi.org/10.1007/s13580-018-0024-0

López, S.E.M., Pazos, A., Rivero, G.A., Crespo, J.P.M., y Vargas, C.Z. (2018). Morfometría de fruto y semilla de Moringa oleifera Lam. "moringa". *Sciéndo Ciencia para el desarrollo*, 21(2), 201-204.

Ojuederie, O.B., Igwe, D.O., Okuofu, S.I. & Faloye, B. (2013). Assessment of genetic diversity in some *Moringa oleifera* Lam. landraces from Western Nigeria using RAPD markers. *The African Journal of Plant Science and Biotechnology*, 7(1), 15-20.

Onyekwelu, J.C. & Olabiwonnu, A.A. (2010). Seed germination and early growth of moringa oleifera seedlings. *Forests and Forest Products Journal*, 3, 12-19.

Padulosi, S., Thompson, J., & Rudebjer, P. (2013). Fighting poverty, hunger and malnutrition with neglected and underutilized species (NUS): needs, challenges and the way forward. Bioversity International, Rome, 11-48.

Popoola, J.O., & Obembe, O.O. (2013). Local knowledge, use pattern and geographical distribution of *Moringa oleifera* Lam. (Moringaceae) in Nigeria. *Journal of Ethnopharmacology*, 150, 682-691

Rao, V.R. & Hodgkin, T. (2002). Genetic diversity and conservation and utilization of plant genetic resources. *Plant Cell, Tissue and Organ Culture*, 68, 1–19,

Ruiz-Hernández, R., Hernández-Rodríguez, M., Cruz-Monterrosa, R.G., Díaz-Ramírez, M., Jiménez-Guzmán, J., León-Espinosa, E.B., García-Garibay, M., Fabela-Morón, M.F., Pérez-Ruiz, R. V. & Rayas-Amor A. A. (2021). Morphological characterization of *Moringa oleifera* seeds from different crops of Mexico. *Agro Productividad*. https://doi.org/10.32854/agrop.v14i11.2175

Saini, R.K., Saad, K.R., Ravishankar, G.A., Giridhar, P., & Shetty, N.P. (2013). Genetic diversity of commercially grown *Moringa oleifera* Lam. cultivars from India by RAPD, ISSR and cytochrome P450-based markers. *Plant System & Evolution*, 299, 1205–1213

Shahzad, U., Khan, M.A., Jaskani, M.J., Khan, I.A. & Korban, S.S. (2013). Genetic diversity and population structure of *Moringa oleifera*. *Conservation Genetics*, DOI 10.1007/s10592-013-0503-x

Zhigila, D.A., Mohammeda, S., Oladeleb, F.A., & Sawac. FBJ (2015). Numerical analyses of leaf and fruit external morphology in Moringa oleifera Lam. *Journal of Sciences & Engineering*, 77(13), 123-131.

87 EFFECT OF VARIETY AND INTRA-ROW SPACING ON GROWTH AND YIELD CHARACTERS OF HYBRID MAIZE (*Zea mays*) IN FCT

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Abstract

This study was carried out at the Research Farm of the Faculty of Agriculture, University of Abuja in the Southern Guinea Savanna Zone of Nigeria, during the cropping season of 2019 to evaluate the effect of variety and intra-row spacing on growth and yield characters of hybrid maize in Federal Capital Territory (FCT). Two hybrid maize varieties Dekalb920 and Dekalb 818 sourced from National Seed Council of Nigeria were evaluated under five different intra-row spacing's of 14, 18,21,25and 30cm, with gross plot of 15m and net plot 0f 9m and Parameter such as plant height, , leaf area index, stem diameter and yield were evaluated. It was a factorial combination experiment laid out in a Randomized Complete Block Design (RCBD) with three replicates. Data collected were subjected to Analysis of Variance (ANOVA) and means were separated using Duncan multiple range test. The results obtained from the experiment 12th weeks after sowing indicated that hybrid variety Dekalb920 had mean plant height of 273.06cm, leaf area index of 14.03cm2 and yield of 8.0t/ha among other parameters was superior to Dekalb818 variety investigated. With respect to intra-row spacing, plants sown on 14 cm had higher plant height and leaves area index of 287.7 cm and 14.03cm, respectively while plants sown on intra-row spacing of 30 cm had plant height of 268.0 cm2 and leaves area index of 11.57 respectively. The result showed that Variety and Intra-row spacing had significant influences on the growth parameters, yield and yield components of maize. The result also indicated that variety Dekalb 920 was the more suitable of the two maize varieties tested, and 14cm and 25cm intra-row spacing was better to achieve optimum yield in Federal Capital Territory (FCT)
Keywords— Maize; varieties; spacing; growth; yield;

INTRODUCTION

Maize (*Zea mays* L.) is the world's largest cultivated cereal crop with over 872 million metric tons (MT) produced in 2012 (FAO, 2016), and one of the most important cereals used for food and feed production (IITA, 2006). The use of maize as staple food is as follows: 78% for human consumption, 17% for feed and residual uses, and about 5% for re-planting (United States Department of Agriculture USDA). Maize is produced in all the agro-ecological Zones of Nigeria except in the Sahel Savannah. The largest area of production is the Northern Guinea Savannah (Manyong *et al*., 1996). Twenty-two states in Nigeria including the Federal Capital Territory (FCT) have high production rate of maize in which 17 out of the 22 states are in the Northern part of the Country and their high production of maize are rated in three categories as in medium to high potential in production (Olaniyan, 2002).

Spacing is one of the important factors that affect corn yield and due to its genetic potential; corn yield is different under various plant populations (Abuzar *et al*., *2011*). According to the Sangoi (*2001*) there is no specific optimum population density for all the weather conditions since it differs based on environmental and controlled conditions Low plant density causes minimum corn yield due to the leaf area's little plasticity in each plant (Lashkari *et al*., *2011*). Therefore, the objective of the experiment is to compare the performance of the varieties of maize used in this trial as influenced by the different intra- row spacing.

Materials and Methods

The experiment was conducted at the Research Farm of the Faculty of Agriculture, University of Abuja, in the Southern Guinea Savanna Zone of Nigeria, during the cropping season of 2019.

The Experimental land was mechanically ploughed using a tractor mounted disc plough, and then harrowed twice to break the soil clods. Most of the debris was ploughed back into the soil then the experimental plots were laid out using measuring tape and pegs. The Planting materials used for the trial were two varieties of maize Dekalb 920 and 818. The maize varieties were obtained from National seed council of Nigeria. Abuja.

The experimental treatments were 5 different intra-rows spacing of 14cm (B_1), 18cm (B_2),21cm(B_3),25cm (B_4), and 30cm(B_5) by 75cm inter row spacing and two maize varieties. Dekalb920 (A_1) and Dekalb 818(A_2) Thus, a 2 x 5 factorial combination trial was used for the treatments and making a total of 10 treatment combinations. Randomized Complete Block Design (RCBD) with 3replications was adopted. Factorial arrangement was used in organizing the treatments which were fitted into the Design Each replicate contained 10 plots, of 3m×5m sizes giving 15m^2 gross plot and 9m^2 net plot and separated by 1m allay pathway. Thus a total of 30 plots were used for the experiment.

Sowing of one seed per hole was done on the 22nd July 2019.The various plant spacing gave the different plant populations. Maize seeds were sown at depth of 3cm in plots measuring 5m x 3m using five different spacing's listed above. Fertilizer and weed control practices was done appropriately. Agronomic parameters taken includes plant height(cm), leave area index, stem diameter(cm), plant stand count, number of days to 50% tasseling and silking and grain yields (tons/ha).

Data collected were subjected to Statistical analysis for Analysis of Variance (ANOVA) using SAS

– Statistical Analytical Structure procedure and the means were separated using Least Significant Difference (LSD)

RESULTS

The results showed that variety and spacing were significantly ($P< 0.05$) different throughout the period of evaluation and positively affected the stand count. The effect of intra-row spacing on the stand count of two maize varieties Dekalb 920 and Dekalb 818 is shown in Table 1. The two varieties gave statistically similar percent stand count in respect to the intra-row spacing however, varying intra-row spacing shows significant differences in emergence of two maize varieties. Spacing 14 cm gave the highest count stand while 30 cm gave the least stand count of maize.

There were significant differences also in the plant height of the maize varieties investigated. Variety 920 gave taller plants of 287.7 cm at 9th weeks after sowing, followed by 818 with height of 281.7cm. With respect to spacing, maize plants sown at 14 cm in 2019 gave taller than other plants spacing during the 9th weeks with height of 287.7 cm and 281.7cm for variety one and two respectively at 9thweeks. These were followed by plants sown at 18cm; 21cm and 25cm. Plants sown at 30cm were the shortest. The results showed that variety and spacing were significantly ($P< 0.05$) different throughout the period of the evaluation and positively affected plant height. Varietal differences did not result in significant differences in LAI in the evaluation. Varying spacing caused significant differences in LAI, with each decrease in spacing significantly increasing LAI in sampling period. The results showed that variety and spacing were significantly ($P < 0.05$) different and positively affected leaf area index of maize.

Variety 920 had the highest stem girth of 11.20cm, while variety 818 had 11.00cm at 9th week after sowing. Based on spacing, maize plants sown at spacing of 30 cm were superior in stem girth while plants

Table 1: Effect of variety and intra-row spacing on Stand Count/Plot, Plant Height (cm), leaf Area Index, Stem Diameter, Days to 50% tasselling and Grain yield (t/ha) of maize

	Stand Count/ Plot		Plant Height (cm)		leaf Area Index		Stem Diameter (cm)		Days to 50% tasselling		Gain yield (t/ha)	
Spacing (cm)	Variety 1	Variety 2	Variety 1	Variety 2	Variety 1	Variety 2	Variety 1	Variety 2	Variety 1	Variety 2	Variety 1	Variety 2
14	138.67	139.67	287.7	281.7	14.03	13.77	8.2	8.03	56.67	56.33	7.7	7.33
18	107	108	275.3	275.7	13.07	13	8.7	8.57	56.67	57.33	6.3	7.27
21	94	92.33	272.7	271	12.5	12.33	9.13	9.03	57.33	56.33	6.63	6.27
25	75.33	76	275	266	12.2	12.13	9.77	9.5	56.67	57	8	7.13
30	64.67	63	268	260.3	11.57	11.4	10.33	10.23	56.67	56.33	6.03	5.33
Grand Mean	88.67	88.67	273.06	267.7	12.44	12.29	9.56	9.39	56.67	56.67	6.77	6.61
LSD ($\alpha < 0.05$)	2.95	2.88	7.53	10.11	0.18	0.45	3.07	2.63	0.99	0.81	1.12	0.94

Means with the same letter in a column of each factor are not significantly different at ($P \leq 0.05$), LSD = Least Significant Difference, V1= Dekalb 920, V2 = Dekalb 818

own at spacing of 14 cm had the smallest stem girths. The results showed that variety and spacing were significantly ($P < 0.05$) different and positively affected stem girth of maize.
There was no significant difference between Dekalb 920 and 818 maize varieties on number of days to 50% tasseling and silk. The results showed that variety and spacing were not significantly ($p > 0.05$) different.

The analysis revealed that the effect of variety and intra-row spacing and the plant density was significant ($P < 0.05$) for grain yield as shown in (table 9). Mean comparisons showed that Dekalb 920 maize variety at 25cm spacing had the highest yield of (8.00ton/ha average) and was followed by 14cm spacing which had (7.7*0* ton/ha average) which was due to grain weight. Also, Dekalb 818 variety at 14cm spacing had the third highest yield (7.33ton/ha average) and was followed by 18cm spacing which had (7.27ton/ha average). The result shows that the two varieties at 14cm intra- row spacing had a higher grain yield compared to the 30cm intra- row spacing which means that the trend of changes in the two maize varieties to row spacing was similar and positively affected grain yield of maize.

DISCUSSION

The differential growth with respect to plant height observed among the two varieties may be attributed to differences in genetic characteristics of the individual varieties, including rapid growth rates, tallness or shortness of the varieties. This is similar to the findings of Ibrahim *et al.* (2000) that attributed the differences in growth indices of crops to genetic constitution. Maize plants spaced 14cm intra-row spacing was taller than other plants possibly because of increased competition for space, sunlight and available nutrients. It is also consistent with the reports of Al-Rudha and Al-Youmis (1998) that maize sown at 15cm had the highest plant height compared with their counterparts sown at wider intra-row spacing. The increase in plant population with the decrease of plant spacing obtained in this study is obvious since plant spacing is used as a tool to increase or decrease plant density. These results were supported by Roy and Biswas (1992) who reported that, narrow plant spacing had resulted in high plant population.
The highest leaf area index obtained in 14cm intra-row spacing by the two varieties in this study could be due to variation in environmental factors, influenced by genotype, plant population, climatic condition and soil fertility. Higher plant population produced which offset the effect of large leaf area produced at 30cm intra-row spacing. This result is supported by Winter and Ohlrogge (1973) who reported that leaf area index increased with the increase of plant population.

The comparison of means indicated the maximum of days to 50% tasseling (57 days) was recorded in all intra-row spacing. Gungula *et al.* (2003) suggested that increase in plant density might have increased the rate of photosynthesis and delayed phenological characteristics such as tasseling in maize. Amanullah *et al*. (2009) reported that, plots maintained at high density took slightly more time to tasseling and physiological maturity than the plots maintained at low density.

The superiority of Dekalb 920 maize variety over Dekalb818 maize with respect to grain yield may be attributed to the special qualities credited to the hybrids, including disease resistance, early maturity, uniformity in flowering and ear-placement, and very high yield and the genetic make-up of the Variety. This is similar to the findings of Udoh (2005) who reported that, some hybrid maize varieties have yield advantage over other maize varieties because they possess such special qualities as high yield, disease resistance, and early maturity, uniformity in flowering and ear placement. Maize plants sown at spacing of 25cm were superior in grain yield and closely followed by maize sown at spacing 14cm. However, the higher grain yield obtained at closer intra-row spacing (25cm and 14cm), could be attributed to higher number of plants and harvestable cobs at optimum spacing. This result was in conformity with the findings of Okan *et.al.* (2004) that obtained highest grain yield from closest intra-row spacing of 20cm.There was no significant differences in yield ha-1 between the two varieties.

CONCLUSION and RECOMMENDATION

The result of present study showed that Variety and Intra-row spacing had significant influences on the growth parameters, yield and yield components of maize. The result also indicated that variety Dekalb 920 was the more suitable of the two maize varieties tested, and 14cm and 25cm intra-row spacing was better to achieve optimum yield in FCT

REFERENCES

Abuzar, M. R. Sadozai, G. U. Baloch, M. S. Baloch. A.A. ShahI, H. Javaid T.and Hussain N. (2011). Effect of plant population densities on yield of Maize. *Journal. Animal. PlantScience*. *21*(*4*): *692-965*.

Al-Rudha, M. S. and Al-Youmis, A. H. (1998). The effect of row spacing and nitrogen levels on yield, yield components and quality of maize *(Zeamays L.)*. *Iraqi Journal of Agricultural Science,* 13: 235 - 252.

Amanullah, K. Riaz, A and Shad K. (2009). Plant density and nitrogen effects on maize phenology and grain yield.*Journal Plant Nutrition*. 2009; 32(2): 246–60.

FAOSTAT (Food and Agriculture Organization of the United Nations) (2016)

Gungula, D.T.Kling, J.G and Togun AO. (2003). Predictions of maize phenology under nitrogen-stressed conditions in Nigeria. *Agronomy Journal*; 95: 892–9.

Ibrahim, K. Amans, A. and Abubakar, I. U. (2000). Growth indices and yield of Tomato (*Lycopesicon esculentumkarest*) varieties as influenced by crop spacing at samaru. *Proceedings of the 18th HORTSON Conference Proceedings (1): 40-47.*

IITA (2006). Morphology and growth of maize. IITA Research Guide 9.International Institute of Tropical Agriculture, Ibadan.

Lashkari, M. Madani, H. Ardakani, M. R. Golzardi, F and Zargari, K. (2011). Effect of plant density on yield and yieldcomponents of different Corn (Zea mays L.) hybrids.AMEuras.J. Agric. & Environ. Sci. *10* (*3*):*450-457*.

Okan, S. Huseyin, G. Omer, K and Mehmet, K (2004). The effect of intra-row spacing on grain yield and Agronomical characteristics of maize (*Zea mays* L.) hybrids.*Asian Journal of Plant Science*.3(4): 429-432

Olaniyan, A.B and Lucas, E.O (2002). Effect of periodic reduction in density of planting on yield of maize genotypes in southwestern Nigeria. Res. Crops J. 3(2):315-321.

Roy and Biswas, P. K. (1992). Effect of plant density and detopping following silking on cob growth fodderand grain yield of maize.J. Agric. Sci. 119:297 – 301.

Sangoi, L. (2001). Understanding plant density effects on maize growth and development: important issue to maximize grain yield. Ciencia Rural.*31*(*1*): *159-168*.

Udoh, J. (2005). Crop Production Techniques for the Tropics Concept Publications Limited, Munshin, Lagos Nigeria. Pp. 101-106.

88 RESPONSE OF HYBRID LINES OF SWEET POTATO TO THE APPLIED PLANT EXTRACTS, WOOD ASH AND NPK FERTILIZER IN ABUJA, NIGERIA

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Abstract

The study, conducted to determine the response of hybrid lines (UMOSPO 1 and KWARA) to the applied plant extracts (Moringa oleifera), wood ash and NPK fertilizer was conducted at the Teaching and Research farm of National Biotechnology Development Agency, Abuja - Nigeria. Factorial treatment arrangement fitted into Randomized Complete Block Design with 3 replications was used and the results showed that the status of some basic elements, (N,P,K, Mg and Ca) was significantly enhanced especially in the plots that received Moringa extract and wood ash. Soil pH of the plots that received wood ash increased from 5.2 to 6.7 while those given Moringa extracts increased from 5.2 to 5.8 irrespectively of varieties of sweet potato. Stand count of the stands per plot before harvest showed that stands amended with various treatments were higher than that of the control plots by the following percentage, Moringa extract (20%), NPK (18%), and wood ash (12%) respectively. When compared with the yield from control plots, plots amended with Moringa extract produced 74% more root yield than the control, wood ash by 58%, and NPK fertilizer by 70% respectively. While stands of sweet potato treated with Moringa leave extract produced significantly, ($p < 0.05$) greater number of marketable roots, those that received NPK fertilizer produced more unmarketable roots followed by those in the control plots in terms of severity of infection by Cylas weevils on the storage roots, stands treated with Moringa extracts showed very mild symptoms while those applied with wood ash showed moderate symptoms but roots from NPK Fertilizer amended plots and the control plots showed severe symptoms of infection.

Keywords: Sweet potato; Wood ash; Moringa leaf extract; NPK fertilizer; Cylas weevil

Introduction

Sweet potato [*Ipomoea batatas* (L.) Lam.] is one of the world's most important food crops, with annual production which amounted to approximately 89.5 million metric tons (FAO, 2019). Of the staple food crops grown, including cassava, rice and maize, sweet potato is the crop with the highest potential for commercial exploitation (Kenneth, 2009). The crop is the fifth most important food crop after rice, wheat, maize and cassava (FAO, 1998) and an important food and vegetable crop that grows throughout the world, especially in the tropics and warm tropical areas for its edible tubers. Although, sweet potato is not usually regarded as source of protein, but it contributes

3.40% to total protein intake compared with 4.5%, 4.8% and 5.8% contributed by eggs, fish and cheese respectively (Wolfe, 1992).

Many studies have suggested that increasing consumption of plant foods like sweet potatoes decreases the risk of obesity, diabetes, heart disease and overall mortality while promoting a healthy complexion, increased energy, and overall lower weight (Ewell and Mutuura, 1991). In addition, sweet potato skin contributes significant amounts of fiber, potassium and quercetin, (Ewell and Mutuura 1991).

One of the most limiting factors in sweet potato production has been lack of desirable varieties. Currently the problem seems to have been taken care of by the production of highly advanced breeding Lines capable of producing more than 30 tones ha [1], by Agricultural research Institutions such as National Root Crop Research Center, Umudike. Unfortunately, most of these high yielding varieties are highly susceptible to the weevil known as, *Cylas*. *Cylas* spp is a very serious pest of sweet potato, especially the orange-fleshed varieties (Fig 1 and 2). They feed on the tubers of the sweet potato, leaving behind numerous small black holes on the affected tubers which render its qualities - eating and market, useless.

The study is intended to achieve the following objectives.

(a) To compare the effects of the plant extracts, wood ash and chemical fertilizer on the soil properties and the yield of the varieties of sweet potato used in the study.

(b) To determine whether the plant extracts and wood ash would be suitable alternatives to chemical fertilizers in the production of sweet potato.

Materials and Method

The study, conducted to determine the response of hybrid lines (UMOSPO 1 and KWARA) to the applied plant extracts (*Moringa oleifera*), wood ash and NPK(20:10:10) fertilizer was conducted at the Research farm of National Biotechnology Development Agency in 2018 cropping season, along Airport road, Abuja, Nigeria. Abuja, the Federal Capital Territory, is located in the Guinea Savannah of the West Africa. The sweet potato vines UMOSPO 1 and KWARA were sourced from National Root Crop Research Institute Umudike, Nigeria. The varieties used are high yielding and have been under Pre – Release evaluation for recommendation to farmers in Nigeria. These varieties constitute factor A (UMOSPO 1 (A1) and KWARA (A2) while Factor B; wood ash (B1), *Moringa* leaves extracts (B2) NPK20:10:10(B3) control (B4), thus a 2x4 factorial combination, making a total of 8 treatment combinations was used. Randomized Complete Block Design with

3 replications was used. Factorial arrangement was used to organize treatments which were fitted into the design. Each replicate contained 8 plots and Plot size was 3m x3m and planting spacing was 1m x 0.3m. Plant population per plot was 30 stands and inter plot spacing was 1m. During planting, 2/3 of the length of each vine (20cm long) was inserted into the soil, at an angle of 60^o. The soil around the vine was firmly pressed to ensure proper contact of the vine with the soil for easy establishment. First weeding was done three weeks after planting using hoes and fertilizer NPK 20:10:10 was applied after weeding, at the rate of 400kg per hectare. A plot received 360g of N.P.K fertilizer. Thus, each ridge received 120g of N.P.K 20:10:10 fertilizer. Two times weeding was done before the vine leaves covered the ground surface, suppressing weed in the process.

Data collected were.

Stand count at harvest, mean marketable (> 150g) root weight (kg/plot), mean unmarketable root weight (kg/plot), mean number of marketable roots per plot, mean number of unmarketable roots per plot, mean root *Cylas* weevil incidence (i.e. total number of roots with *Cylas* weevil),

Mean root *Cylas* weevil severity score, where

1 = All tubers clean of *Cylas* damage across the plot

2. = <20% of each tuber in the plot damaged

3. = 21 – 50% of each tuber in the plot damaged

4. = 51 – 80% of each tuber in the plot damaged by *Cylas*

5. = >80% of each of the tubers in a plot damaged

Soil analysis data collected were subjected to analysis of variance (ANOVA) using Duncan Multiple Range Test to separate means.

Results and Discussion

Result Tables

Table 1.Pre – planting Soil Physicochemical properties of the experimental site

Parameters	Before Planting
pH in water (1:2.5)	5.2
% Organic matter	0.52
Total Nitrogen	0.43
P (ppm)	10.3
K (Cmol kg^{-1})	0.47
Mg (Cmol kg^{-1})	2.38
Na (Cmol kg^{-1})	1.44
Clay (%)	36.6
Silt (%)	16.9
Sand	41

Table 2. Mean Root yield and Yield Components of selected sweet potato used

Varieties	Application	Stand Count/plot	Marketable Roots/plot	Unmarketable Roots/plot	Root Yield/t ha^{-1}
UMOSPO 1	wood ash	24cd	23.4cd	10.3e	7.5g
UMOSPO 1	*Moringa* extracts	28a ,	38.5a	8.2e	19.3b
UMOSPO 1	NPK20:10:10	25bc	20.9d	21.1b	17.2c
UMOSPO 1	control.	20e	6.5i	16.2c	3.5h
KWARA	wood ash	24cd	26c	5.3f	10.2f
KWARA	*Moringa* extracts	28a	38.2a	5.2f	21.8a
KWARA	NPK20:10:10	27a	20.7e	26.3a	21.6a
KWARA	control.	20e	8.4i	15.6c	3.1h

DMRT (P>0.05)

Table 3. Severity of infestation of *Cylas* weevil on the Storage roots of the Selected Sweet Potato.

Varieties	Application	No. of Roots with *Cylas* weevil/plot	Severity Score
UMOSPO 1	wood ash	8.3	3
UMOSPO 1	*Moringa* extracts	5	2
UMOSPO 1	NPK20:10:10	18	4
UMOSPO 1	control.	14	4
KWARA,	wood ash	4	2
KWARA	*Moringa* extracts	4	2
KWARA	NPK20:10:10	17	4
KWARA	control.	12	3

Mean SPVD severity score at 10 weeks after planting where

1. = No visible SPVD symptoms on all plants in the plot
2. = Very mild symptoms on infected plants
3. = Moderate symptoms on infected plants
4. = Severe symptoms on infected plants and
5. = Very severe symptoms on infected plants (plants are stunted, leaves shriveled)

Fig 1: *Cylas formicarius*

Figure 2: Storage damage caused by *Cylas* spp

Table 4. Post-harvest Soil Properties on the response of sweet potato hybrids used

Varieties	Application	Physical properties			Elements		%organic matter			
Clay Silt	Sand pH	N	P	K	Mg		%	ppm	<-cmolkg^{-1}->	
UMOSPO 1	wood ash	38	18	43	6.7	0.12	12.4	0.57	2.61	0.43
UMOSPO 1	*Moringa* extracts	37	18	40	5.8	0.41	8.6	0.51	2.37	0.58
UMOSPO 1	NPK20:10:10	37	17	40	4.8	0.53	14.7	0.51	1.88	0.37
UMOSPO 1	control.	38	17	40	4.5	0.21	9.5	0.34	1.10	0.11
KWARA	wood ash	38	18	41	6.6	0.48	10.2	0.48	1.43	0.36
KWARA	*Moringa* extracts	38	18	40	5.8	0.48	8.5	0.44	1.18	0.46
KWARA	NPK20:10:10	38	18	40	4.8	0.55	13.6	0.53	1.34	0.27
KWARA	control.	38	18	41	4.6	0.24	5.6	0.33	0.74	0.28

Table 1 shows the fertility status of the experimental site determined before the commencement of the experiment. The result indicates that the soil fertility was relatively poor and that may be attributed to the continuous cropping in the area as indicated by the cropping history. The site was under one year fallow following a two-year Okra trial. Esu, (2010) classified the soil in the area as Alfisols, well drained and strongly acidic giving credence to the pre-planting soil analysis that showed a soil pH value of 5.2.

However, after the experiment, Postharvest soil analysis showed that the status of some basic elements, (N P K Mg Ca) was significantly enhanced especially in the plots that received a *Moringa* extract and wood ash (Table 4). Percent nitrogen and phosphorus were relatively higher in plots that were given NPK fertilizer. The large concentration of phosphorus in the NPK amended plots may be due to the immobilization of the element due to low soil pH. Soil pH was significantly improved with the application of wood ash and *Moringa* extracts respectively. The pH of the plots that received wood ash increased from 5.2 to 6.7 while those given *Moringa* extracts increased from 5.2 to 5.8 irrespective of varieties of sweet potato. Onwuka e*t al.*, (2009) reported that application of wood ash improved the soil pH level thereby creating conducive environment for healthy plant growth. Enhanced pH values tend to increase the Cation Exchange Capacity of the soil. Under this situation the basic cations are significantly available to the plant for their nutrition. Thus the enhanced performance of the varieties of potato that were given wood ash and *Moringa* extract respectively might partly be due to improved soil pH. *Moringa* has been reported to significantly improve soil fertility if used as a green manure, (Davis 2000). In control plots, the pH decreased from 5.2 to 4.6 and from 5.2 to 4.8. Inorganic fertilizers are known to increase the hydrogen ion concentration in the soil thereby reducing the soil pH drastically. Owolabi *et al.*, (2003) further added that at lower pH values, potatoes can suffer from aluminum and other heavy metal ion toxicity, as well as restricted P or Mo availability. In this study, the values of sodium ions increased as the soil pH decreased (Table 4), giving credence to the reports of Onwuka *et al.*, 2009. Concentration of sodium ions is known to be detrimental to crop growth and development. The physical properties of the soil remained fairly the same even after the trial.

Table 4 showed the yield and yield component of the selected varieties of sweet potato as influenced by *Moringa* leaf extract, wood ash and NPK fertilizer. Stand count of the stands per plot before harvest showed that stands amended with various treatments were higher than that of the control plots by the following percentage, *Moringa* extract (20%), NPK (18%), and wood ash (12%) respectively. Thus crop survival was more in plot amended with *Moringa* extracts than others. Phiri, (2003) pointed out that *Moringa oleifera* leaves have high zeatin content. Zeatin is a plant growth hormone from the cytokynesis group. It plays an important role in cell division and cell elongation (Taiz and Zeiger, 2000), thus improving crop growth and yield.
Generally application of the various treatments significantly ($P>0.05$) improved the root yield of the varieties of potato selected in this study. High root dry matter (DM) content (25.5% and above) is preferred in the Sub Saharan Africa especially in Nigeria because of the various food preparations that sweet potato is generally used for. When compared with the yield from control plots, plots amended with *Moringa* extract produced 74% more root yield than the control, wood ash by 58% and NPK fertilizer by 70% respectively. While stands of sweet potato, irrespective of varieties, treated with *Moringa* leave extract produced significantly~~,~~ ($p< 0.05$) greater number of marketable roots, those that received NPK fertilizer produced more unmarketable roots followed by those in the control plots. In Zambia, Moringa has been reported to increase crop growth and yield, (Foidl, *et al.*, 2001). *Moringa* accelerates rate of young plants, strengthens plants, prolongs life span, increases number of roots , stems and leaves, produces more and large fruits and generally increased yield by 20 – 35%, (Fugile, 2000).
Irrespective of treatments applied, UMOSPO1 performed relatively higher compared to the local variety, Kwara. In terms of severity of infection by *Cylas* weevils on the storage roots, stands

treated with *Moringa e*xtracts showed very mild symptoms while those applied with wood ash showed moderate symptoms but roots from NPK Fertilizer amended plots and the control plots showed severe symptoms of infection. Fugile, (2001) reported that *Moringa* extracts improve resistance to pests and diseases.

Conclusion and Recommendation

Irrespective of application, UMOSPO1 was higher in terms of yield. Also, Moringa and wood ash gave a better post soil quality and Cylas symptoms was very mild to zero effect, thus, farmers can adopt this practice

REFERENCES

Davis, K. (2000). *The Moringa Tree* (Revised Edition), ECHO, 17391 Durrance Rd, North Ft. Myers Fl, 33917, USA.

Esu, I. E. (2010). *Soil Characterization, Classification and Soil Survey.* HEBN Publishers Plc. Ighodaro Road, Jericho, Ibadan, Nigeria.

Ewell, P. T. and Muturu, J. (1991). Sweet Potato in the food systems of Eastern and Southern Africa In: proceedings of the 9th Sympossium of the International Society for Tropical Root Crops, 20-26 October 1991.

Food and Agriculture Organization (1998). FAO *(http://wwwfao/org/faostrat/ foodsecurity/Index.en.htm.*

FAO (2019). kennFood and Agriculture Organization of the United Nation (FAO) Rome. Available at *htpp//faostat.fao.org/*

Foidl, N, H.P. S Markkar and K. Becker (2001). *The potential of Moringa oleifera for agricultural and industrial uses*. In: Lowel J. Fugile (ed) *The miracle tree: The multiple Attributes of Moringa*, pp: 45-76: CTA; Wageningen, The Netherlands.

Fuglie, L. J. (2000). The Miracle Tree: Moringa oleifera: Natural Nutrition for the Tropics. The Miracle Tree. *The Multiple Attributes of Moringa* 172.

Fugile, I. J. (2001). Miracle Tree: Moringa oleifera: Natural Nutrition for Tropics, p. 172. The Miracle Tree: *The Multiple Attributes of Moringa.*

Kenneth, I. K. (2009) Physiology of yield in Sweet Potato. *www.indexmundi.com/ trade/imports/country=ng&division=04*

Onwuka, M. I., Osadeke, V. E. and Eno, A. O. (2009). Use of Liming materials to reduce soil acidity and effect on maize growth parameters. *PAT:* 5(2): 386- 389.

Owolabi, O., Adeleye, A., Oladejo, B. T. and Ojeniyi, S. O. (2003). Effect of wood ash on soil fertility and crop yield in southwest Nigeria. *Nigeria Journal of Soil Science,* 13: 55-60.

Phiri, C. (2010). Influence of Moringa oleifera leaf extracts on germination and early seedling development of major cereals. *Agriculture and Biology Journal of North America*, 1(5): 774-777.

Taiz, L. and Zeiger, E. (2006). *Plant Physiology* (Fourth ed.) Sinauer Associates, Sunderland, MA, p764. USA.

Wolfe, J. (1992). *Sweet Potato. An untapped Food Resources.* Cambridge: University Press, U.K

89 RESPONSE OF GROWTH AND YIELD OF MAIZE (*ZEA MAYS* L.) TO LIME INORGANIC AND ORGANIC FERTILIZER IN MOKWA, NIGER STATE OF NIGERIA

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Abstract

Proper integrated nutrient management is essential for plant growth, yield efficiency and soil health maintenance. A field trial was conducted to investigate the effect of lime, inorganic and organic fertilizer on growth and yield of maize on farmers' field at Rabba, Mokwa, Local government area of Niger State. The field trial was conducted in the year 2021 (rainy season). The treatments consisted of lime, organic, and inorganic fertilizer combinations. T^1: control (no input), T^2: 300 kg ha^{-1} of NPK (OCP special blended NPK micro nutrient fortified fertilizer), T^3: 0.5 t ha^{-1} Agric.- lime + 300 kg ha^{-1} NPK (OCP special blended NPK), T^4: 0.5 t ha^{-1} Agric.- lime + 5 t ha^{-1} cow dung (organic) + 300 kg ha^{-1}NPK (OCP special blended NPK), T^5: 5 t^{-1} ha of cow dung + 300 kg ha^{-1}NPK (OCP special blended NPK), arranged in Randomized Complete Block Design (RCBD) with three farmers' field as replicates. The gross plot size was 6 m x 6 m (36 m^2). The leaf area, husk with cob weight, cob weight and grain yield were measured as at when due. The results showed that maize were significantly improved with application of lime, inorganic fertilizer and organic manure with respect to all parameters taken as compared to the control which had the lowest growth and yield parameters across the farmers field in the study area, therefore the application of 0.5 t ha^{-1} Agric.- lime + 300 kg ha^{-1} NPK (OCP inorganic blend) + 5 t ha^{-1} cow dung recorded the highest yield of maize in the study area.

Key words: Agric. - lime, OCP inorganic blend, Cow dung, Growth, Yield.

INTRODUCTION

Maize (*Zea mays* L.) is one of the important cereal crops in the world that provides essential nutrients for lactating mother for the sustainability of the baby and availability of vitamin A (contributes to the maintenance of normal skin, normal vision and normal function of the immune system). It is the third most important cereal crop after sorghum (S*orghum bicolor*) and millet (*Pennisetum glaucum*) in Nigeria and it is a major staple food that is used as fodder and industrial material with its production at both subsistence and commercial levels in the country (Eleweaya *et al.*, 2005). Maize required a fertile soil to do well. Cultivation of maize in Niger State is being affected by numerous number of factors such as soil acidity, inherent low fertility, imbalance nutrition management, unavailability of the right germplasm, flooding, weed infestation, insecurity, farmers - herdsmen crises, land tenure system, which limit the yield of crops in the state. Likewise modern crop production system is facing a sustainability problem due to indiscriminate use of chemical fertilizer and pesticides (Hidayatullah, 2015) that has resulted in depletion of soil organic carbon, decline in crop productivity and deterioration of nutrient content in the soil. In addition, the continuous and indiscriminate use of chemical fertilizers without organic sources leads to gradual decline of organic matter content and a change on native N status of the soil (Amanullah, 2016). Therefore adequate N sources (organic and mineral) and rates are very important to increase yield and reduce the cost of production and environmental pollution (Fu *et al.*, 2014; Pei *et al.*, 2015). However, chemical fertilizer is associated with decline in some soil properties and crop yields over time and causes serious land problems, such as soil degradation (Hepperly *et al.*, 2009). Integrated use of inorganic fertilizers with organic manures is a sustainable approach for efficiency nutrient usage which enhances efficiency of the chemical fertilizer while reducing nutrient losses (Schoebitz and Vidal, 2016). Farmer's attention hence needs to be drawn to the synergy which results from the combination of organic and inorganic fertilizer to combat food security challenges without soil health deterioration, hence ensuring bumper harvest. This study was designed to determine the influence of combined application of Agric. -lime, inorganic and organic minerals on the growth and yield of maize in the study area.

This study was designed to:

Determine the influence application of Agric. -lime, inorganic and organic minerals on the growth and yield of maize in the study area.

MATERIALS AND METHODS

Description of the study area:

Field trials were carried out at farmer's field (on-farm) at Rabba, Mokwa Local Government Area of Niger State, situated in Southern Guinea Savannah zone of Nigeria. Three farmers field were selected. The experiment was conducted during the 2021 cropping season. The trial field was located at latitude 09^{0} 13^{-} 78^{0}" N and longitude 05^{0}' 01' 761"E, with an elevation of 117m, with mean annual rainfall of 1165.0 mm and mean annual temperature of 26.74^{o}C.

Sources of Experimental Materials:

Pioneer Var. Oba super II was obtained from Agricultural Development project (ADP) farm center Minna, Niger State. Cow dung was collected from animal teaching and research farm Federal University of Technology Minna. OCP special blended NPK micro nutrient fortified fertilizer

($11N-22-p-22k-1B_2 0_3-1zn$) at 300 kg ha^{-1}, Agric. - lime at 0.5 t ha^{-1}, Urea (46 % N) at 189.13 kg ha^{-1} were all gotten from ADP Minna.

Soil Sampling and Analysis:

Soil samples were collected with a soil auger from the field randomly from 15 points in the entire field at a depth of 0-20 cm. The collected samples were bulked and thoroughly mixed to form a composite sample. The composite soil sample was taken to the laboratory for routine analysis. The sample was air-dried, gently crushed and passed through a 2 mm sieve. The sieved soil was used for determination of soil physical and chemical properties. The soil sample was analyzed according to standard procedures as described by Agbeni (1995). Particles size distribution was determined by Bouyoucos hydrometer method, soil pH was determined in 1:2.5 soil to water and 0.1 M $Cacl_2$ using a glass electrode pH meter. Organic carbon was determined using Walkley-Black method, total nitrogen was determined by micro-Kjeldal method, exchangeable bases (Ca^{2+}, Mg^{2+}, K^+ and Na^+) was extracted with IN neutral ammonium acetate (NH_4OAC) solution and amounts of potassium and Na in solution was determined using flame photometer, calcium and magnesium by sodium EDTA titration method, exchangeable acidity (H^{2+} and Al^{3+}) was determined by titrimetric method with standard sodium hydroxide (0.5 N NaOH) and Effective Cation Exchange Capacity by summation method. Cow dung was also analyzed for N, P and K content.

Treatments and Experimental Design:

Treatment consisted of:

T1 = Control (No input)

T2 = 300 kg ha^{-1} of OCP special blended NPK

T3 = 0.5 t ha^{-1} of Agric. – lime + 300 kg ha^{-1} OCP special blended NPK + Urea

T4 = 0.5 t ha^{-1}of Agric. - lime + 300 kg ha^{-1} OCP special blended NPK + 5 t ha^{-1} Cow dung

T5 = 5 t ha^{-1} Cow dung + 300 kg ha^{-1} OCP special blended NPK The experimental design was a 6 m by 6 m with 1 m apart arranged on a Randomized Complete Block Design (RCBD) with three farmer's field as replicates.

Land Preparation and Agronomic Practices:

The land was cleared manually using simple hand hoe and cutlass. Six (6) ridges were constructed manually with hoe (6 m length) with an inter-row spacing of 75 cm on each plot size of 36 m^2. Application of Agric. – lime 0.5t ha $^{-1}$ and cow dung at 5 t ha^{-1} each was done on the field after land preparation by incorporating into the soil 2 weeks before sowing, three maize seeds were sowed and supplying was done a week after sowing, plants were thinned to one plant per stand 2 weeks after sowing. Manual weeding was done at 3 and 6 WAS to keep the experimental field weed-free. Fertilizer application of OCP inorganic blend, NPK micronutrient fortified fertilizer (11N-22P-22K-1B_2O_3-1Zn) at 300 kg ha^{-1} was immediately done after sowing. Top dressing was done 5 weeks after sowing using urea (189.13 kg ha^{-1}) the total inorganic fertilizer (OCP and Urea) supplied was 120 kg N, 66 kg P_2O_5, 66 kg K_2O ha^{-1}.

Data Collection at Growth Stage:

Data were collected on the following parameters on 8 tagged plants per plot size of 36 m^2 at 6, 8, 10 and 12 WAS. The leaf length and width of the plant tagged were measured using measuring tape multiply by 0.75 (i.e., leaf factor) and was expressed in centimeter square (cm^2). Day to 50 % tasselling was taken at 7 WAS (when half of the plants had tasseled) by visual observation.

Data Collection at Harvest:

The cobs were harvested manually at crop maturity when 90 % of the cobs in the experimental plots turn from green to straw colour (brownish yellow) at about 90-95 days after sowing. Number of cobs on tagged plants was counted and the average was calculated and recorded at harvest. Dry cobs with husk and dehusk cobs were weighed using manual weighing balance (scale) which was expressed in kg ha^{-1}. Grain yield of the plant tagged was weigh using manual weighing balance and been expressed in kg ha^{-1}.

Data Analysis:

The data collected were subjected to statistical analysis using GENstat 11th edition (2000).

Treatment means were separated using Duncan Multiple Range Test (DMRT) at 5 % level of probability.

RESULTS AND DISCUSSION:

The results of cow dung analysis are shown on Table 1. The result revealed that, cow dung contain 2.52 Nitrogen (%) , 0. 04 Phosphorus (%) and 0.39 Potassium (%).The results of the routine analysis are shown on Table 2. It revealed that the soil pH was moderately - acidic in nature. The soil organic carbon was very low (4.77 – 5.74 %) likewise the percent nitrogen was moderately. However, it was noted that the available phosphorus was low. The exchangeable Ca was low in location 1, 2 and very low at location 3. Exchangeable Mg was moderate at locations 1, 2 and low at 3 (1.80, 1.40 and 0.50) respectively. K was low (0.16, 0.22 and 0.14), while Na was moderate at location 1, 2 and low at location 3 (0.40, 0.47 and 0.18), the soil texture is sandy loam in nature. The available micronutrients analyzed (Zinc, Molybdenum and Boron) were all very low in the study sites. Hence, the need for an integrated nutrient management system, to argument the limiting nutrients in the soil and to improve and sustain maize growth and yield in the study area. The widest leaves produced with the application of OCP inorganic blend + Urea, Agric. – lime + OCP + Urea, Agric. – lime + OCP + Cow dung + Urea and Cow dung + OCP + Urea could be attributed to improvement of soil physical and chemical properties of the soil and the supply of sufficient nutrient required for optimum growth of maize. This finding is in conformity with Dasog *et al*., (2012) who reported that balanced application of NPK fertilizers with farm yard manure (FYM) and lime improve sustainable crop productivity and growth of maize. Amit and Auwal (2017) also reported that significant increase in leaf area were observed due to the effect of integrated nutrient management more than sole application of recommended dose of fertilizer. Grain yield is the end result of many complex morphological and physiological processes during the growth and yield development of crop. The heaviest cobs and highest grain yield produced with the application of Agric. – lime + OCP inorganic blend + Cow dung + Urea could be attributed to its multifaceted potential for the improvement of plant performance and resource efficiency while also enabling the protection of the environment and resource quality, this is also in line with khan *et al*., (2008) report. The result is in line with those reported previously (Nagassa *et al.,* 2005 and Shah *et al.,* 2009) who revealed that grain yield was significantly affected by fertilizer in combination with farm yard manure likewise Ayoola and Makinde (2009) observe increased nutrient use efficiency with the combination of inorganic and organic manure.

The treatment combinations might have led to the restoration of soil fertility thereby sustaining crop productivity via the availability of organic matter, major and micronutrients enhancing nutrient use efficiency and favouring the physical, chemical and biological status of the soil. This is confirmed by Golla (2020) who reported that the increase in grain yield of maize might be due to improved physical and chemical properties of the soil through the application of organic manure and adequate quantities and balanced proportions of plant nutrients supplied to the crop by the integrated nutrient management as per needed during the growth period resulting in favorable increase in yield attributing characters which ultimately led towards an increase in economic yield of maize. This study also confirmed that grain yield was significantly higher under integrated nutrient management than unfertilized and chemical fertilizer alone. According to Kakraliya *et al*., (2017), wheat yield with synthetic fertilizer (NPK) 42 % more compared with control (unfertilized), and further increased with the use of organic and inorganic fertilizer along with bio-fertilizers.

Table 1: Cow dung analysis.

Nitrogen (%)	Phosphorus (%)	Potassium (%)
2.52	0.04	0.39

Table 2: Soil routine analysis per farmer's field.

Soil properties	Location 1	Location 2	Location 3
pH	5.7	5.8	6.0
Organic Carbon (%)	4.77	4.77	5.74
Total Nitrogen (%)	0.62	0.53	0.52
Available P (mg kg^{-1})	4.82	7.00	9.24
Exchangeable Cation (cmol kg^{-1})			
Ca	2.00	3.50	3.40
Mg	0.80	3.70	1.00
K	0.16	0.18	0.09
Na	0.35	0.30	0.29
Particle size Distribution (g kg^{-1})			
Sand	858	858	838
Silt	30	10	20
Clay	112	132	142
Textural class	LS	LS	SL

Table 3: Effect of organic and inorganic nutrient management on maize number of leaf area

	Leaf area (cm^2)			
Treatments	6 WAP	8 WAP	10 WAP	12 WAP
Control	267.18b	339.38b	424.06b	72.81b
OCP/Urea	436.56a	546.25a	592.29a	154.69a
Agric.- lime/OCP/Urea	448.75a	46.50a	626.50a	138.44a
Agric.- lime/OCP/Cow dung/Urea	435.94a	545.31a	639.71a	169.38a
Cow dung/OCP/Urea	457.81a	560.00a	597.56a	132.50a
SE±	25.10	28.20	16.99	34.39

Table 4: Effect of organic and inorganic nutrient management on maize yield

Treatments	weight of dry husk plus cob ($plant^{-1}$)	weight of dry cob ($plant^{-1}$)	grain yield (kg ha^{-1})
Control	138.88c	74.07c	277d
OCP/Urea	388.88b	296.29b	14814c
Agric.- lime/OCP/Urea	444.44b	342.59b	19444b
Agric.- lime/OCP/Cow dung/Urea	564.81a	490.74a	2592a
Cow dung/OCP/Urea	444.44b	361.10b	1759bc
SE±	21.32	21.32	8.78

Conclusions

From the results of this study, it was concluded that the application of OCP special blended NPK + Urea, Agric. - lime + OCP special blended NPK + Urea, Agric. – lime + OCP inorganic blend + Cow dung + Urea and Cow dung + OCP special blended NPK + Urea significantly produced similar taller plants, highest number of leaves and largest leaves than the control, which had the shortest plants, lowest number of leaves and smallest leaves in Raba, Mokwa local government. The application of Agric. – lime + OCP special blended NPK + Cow dung + Urea produced heaviest cobs and highest grain yield compared with the control which had the lightest cobs and lowest grain yield on the farmers field in the study area.

Recommendations

Based on the context of this study, it is recommended that farmers in Raba, Mokwa local government area of Niger State of Nigeria should adopt:

(i) The application of OCP special blended NPK /Urea, Agric. - lime/OCP special blended NPK /Urea, Agric.- lime/OCP inorganic blend/Cow dung/Urea and Cow dung/OCP/Urea for increased growth of maize in case the objective is to produce fodder crop.

(ii) While the application of Agric. - lime/OCP special blended NPK /Cow dung/Urea for higher yield and yield attributes of maize for grain production.

References:

Ayoola, O.T. & Makinde, E.A. (2009). Maize growth, yield and soil nutrient changes with a enriched organic fertilizers. *African Journal of food, Agriculture and Nutrition* 9:580-592

Amanullah, H. (2016). Influence of organic and inorganic nitrogen on grain yield and yield components of hybrid rice in Northwestern Pakistan. *Rice Science*, 23 (6): 326-333 www.sciencedirect.com

Amit, K. & Auwal, T.W. (2017). Effect of integrated nutrient management on growth and yield parameters of maize (Zea mays L.) as well as soil physico-chemical properties. *Journal of Scientific and Technical Research*, 1(2), 1 – 6.

Dasog, V.G.S., Babalad, H.B., Hebsur, N.S., Gali, S.K., Patil, S.G & Alagawadi, A.R. (2012). Nutrient status of soil under different nutrient and crop management practices. *Karnataka* 4. *Journal of Agricultural Science*, 193 – 198.

Eleweanya, N.P., Uguru, Mi., Enebong, E, E., & Okocha, P. I., (2005) Correlation and path coefficient analysis of grain yield related characters in maize (*Zea mays L.*) under Umudike condition of south Eastern Nigeria . *AgroScience Journal of Agriculture, Food Environmental and Extension* 4(1) : 24-28.

FU J., Wang Z. Q., Yu L. M., and Yang, J.C. (2014). Effect of growth and yield response of interrogated maize (Zea mays L.). To the application of different rates of inorganic fertilizer and poultry manure.

Golla, B. (2020). Role of integrated nutrient management for enhancing nitrogen use efficiency in crop. *Open Journal of Plant Science*, 5(1), 1 – 12.

Happerly Y.P. lotter, D., Ulsh, C. Z. Siedel R. & Reider, C. (2009). Compost manure and synthetic fertilizer influence crop yields, soil properties, nitrate leaching and crop nutrient content compost Science Util 17, 117 -126 (links)

Hidayyatulla A. (2015). Sources rations and mixture of organic and inorganic nitrogen influence on plant height of hybrid rice (*Oryza sativum*) at various growth stages of Agriculture 2(3) 328-337

Kakraliya, S.K., Jat, R.D., Choudhari, K.K & Prakash, J. (2017). Integrated nutrient management for improving, fertilizer use efficiency, soil biodiversity and productivity of wheat in irrigated rice wheat cropping system in Indo-Gangatic plains of India. *Journal of Current Microbiology and Applied Science*, 6, 152 – 163.

Kalhapure, A.H., Shete, B.T. & Dhonde, M.B. (2013). Integrated nutrient management in maize (*Zea mays* L.) for increasing production with sustainability. *International Journal of*

Agriculture and Food Science Technology, 4, 195 – 206.

Pei, P.G., Zhang J.H., Zhu L.F., Hu, Z.H. & Jin, Q.Y. (2015). Effect of straw returning coupled with application on rice photo synthetic characteristic, nitrogen uptake and grain yield formation

Shah, S.T.H., Zamir M.S.I. & Khalid, W.B. (2009). Growth and yield response of maize (Zea mays L.) to organic and inorganic sources of nitrogen. *Pakistan Journal of Life Social Science* 7: 108-111

Schoebitz, M., & Vidal, G. (2016). Microbial consortium and pig slurry to improve chemical properties of degraded soil and nutrient plant uptake *Journal. of Soil Science. plant Nutr*ition 16(1), 226-236 (links) china journal of rice science 29 37: 282 -290.

90 DETERMINATION OF IRON AND ZINC CONTENTS OF RICE VARIETIES AND LAND RACES IN NIGERIA USING ATOMIC ABSORPTION SPECTROMETRY ANALYSIS (AAS)

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Abstract

Reliable information on the Iron (Fe) and Zinc (Zn) content in rice varieties is crucial to developing an effective breeding program to produce micronutrients dense food through biofortification. The development of elite and superior rice progenies combining high yield with high Fe and Zn content would offer a practical solution to combat nutritional problems affecting the burgeoning populations in Africa. In this study, therefore, 61 rice genotypes (comprised of 48 released varieties and 13 landraces) were screened to determine their Fe and Zn status. The screening exercise was conducted in the Laboratory of the Department of Biotechnology, National Cereals Research Institute (NCRI), Badeggi, Niger State, Nigeria in March 2020. The experiment involved the preparation of samples, wet digestion and determination of Fe and Zn content using an Atomic Absorption Spectrometry machine (AAS- WIN 500 PG INSTRUMENT). The results obtained showed significant variability in the content of Fe and Zn in all the samples tested. The majority of the released and commercial and commonly cultivated varieties such as FARO-44 (Fe: 1.614, Zn: 1.708), FARO-52 (Fe: 1.373, Zn: 2.041) and FARO-67 (Fe: 1.494, Zn: 1.920) contained very low Fe and Zn content. While NGB 00782 and FARO 27 with outstanding Fe content of 6.675 mg kg-1 are good sources of Fe, NGB 00791 (6.697 mg kg-1) and FARO- 49 (6.159 mg kg-1) appeared to be best for Zn.

Keywords: Rice; iron, zinc, atomic absorption spectrometry

Introduction

Rice which is consumed as a staple food in one form or the other by people globally regardless of their social status is a poor source of essential micronutrients such as iron (Fe) and zinc (Zn) (Mallimar *et al*., 2017). While Fe is an essential component of blood, Zn is the main co-factor of several vital enzymes required by the human body to function well (Swamy *et al*., 2018). Thus, an average adult has 3–4 g of iron and 1.5–2.5 g of zinc in the body (Karen *et al*., 2013).

Zinc being a vital cofactor for several enzymes and regulatory proteins performs a significant function in the synthesis of DNA and RNA as well as the expression of genes (Garcia-Oliveira *et al*., 2018). Since Zn controls Fe absorption in the intestines, its deficiency tends to be significantly related to anaemia induced by a lack of Fe in the body (Graham *et al*., 2012). Studies also revealed that globally, mortality of nearly 500,000 children (<5 years of age) is recorded annually due to Fe and Zn deficiencies (Black *et al*., 2013).

Cereal crops and meat are the two major sources of human beings who derive iron and zinc (Karen *et al*., 2013).

Materials and Methods

Collection of the screening population

Seeds of rice genotypes used for this experiment include FARO 4, FARO 15, FARO 16, FARO 17, FARO 19, FARO 20, FARO 21, FARO 22, FARO 24, FARO 27, FARO 31, FARO 32, FARO 33, FARO 34, FARO 37, FARO 38, FARO 41, FARO 44 (SIPI), FARO 45, FARO 49, FARO 51 (CASIDANE), FARO 52, FARO 56 (NERICA-2), FARO 57 (TOX 4004), FARO 58, FARO 61, FARO 62, FARO 63, FARO 64, FARO 65, FARO 66, FARO 67, NCRO 48, NGB 00773, NGB 00775, NGB 00777, NGB 00778, NGB 00779, NGB 00781, NGB 00782, NGB 00783, NGB 00784, NGB 00786, NGB 00789, NGB 00791, NGB 00794, NGB 00827, NGB 00887, THAI JEMEELA, N/ATIME-EJU, N/GORKOCHA, N/MAI-ALURI INJECTION, N/TUDU GAMBO, N/ CHINA CARGO, N/ DOGO-BURI, N/ BIDA ALASKA, N/JANKARA, N/ALOGANI, T/YAR ADIZA, T/ YAR-MAS and T/CD. They were collected from various sources such as the National Cereal Research Institute, Badeggi, Niger State, National Center for Genetic Resources and Biotechnology, Ibadan, Oyo State, National Agricultural Seed Council Abuja as well as farmers' fields from Taraba and Nasarawa States.

Screening of rice population for Fe and Zn contents

Screening of the entire 61 rice genotypes to determine Fe and Zn contents was carried out at the laboratory of the Biotechnology department, National Cereal Research Institute, Badeggi, Niger State in March 2020. The screening exercise involves the preparation of samples, wet digestion and determination of Fe and Zn using the Atomic Absorption Spectrometry machine (AAS- WIN 500 PG INSTRUMENT).

Samples preparation

Ten grams of each rice genotype were collected and cleaned for 30 seconds using a 1.7 mm sieve to remove both organic and inorganic foreign matters. The samples were manually dehusked. The grains obtained were further cleaned with a 1.6 mm sieve to remove immature/shrivelled grains. The whole grains (samples) obtained were later ground into powder using a Thomas Willey milling machine (Model ED-5). The grain powder of each genotype was kept inside a well-labelled paper envelope.

Wet digestion and analysis of samples

Wet digestion of all 61 samples was carried out in the laboratory of the Department of Biotechnology, National Cereals Research Institute, Badeggi, Niger State. The screening of samples was carried out following the procedure below:

1. With the aid of an electronic scale, 0.2 g of sample was measured into a 100 ml volumetric flask.
2. Thirty millilitres (30 ml) of wet digestion acid (650 ml of Nitric acid, 80 ml of Perchloric acid and 20 ml Tetra Oxo Sulphate VI acid) was added into a 1000 ml beaker and stir properly.
3. The samples were placed in a fume cupboard and digested until the sample was reduced to 20 ml volume.
4. The samples were continuously heated until the white fumes of Nitric acid disappear and the sample volume was reduced to 10 ml.
5. The samples were then transferred into a 50 ml volumetric flask and made to mark with distilled water and were shaken vigorously and then filtered through a what man 0.45 um filter paper
6. One millilitre (1 ml) of the clear digest was pipetted into another 50 ml volumetric flask and made up to mark with distilled water.
7. The iron and zinc contents in the samples were determined using Atomic Absorption Spectrometer machine (AA WIN 500 PG INSTRUMENT) with an appropriate wavelength for each of the two micronutrient elements.

Results

The entry point to biofortification through conventional breeding is the screening of the available germplasm to appropriately select promising lines for the target traits. The result of Fe content presented in Table 1 showed significant variability among the various rice genotypes. The highest value (6.675 mg kg-1) was recorded in NGB 00782 and FARO 27 while the lowest (0.048 mg kg-1) was recorded in FARO 45. Furthermore, FARO 19 and NGB 00775 had 6.193 mg kg-1 which was the second highest value. The next was 6.079 mg kg-1 recorded in THAI JAMEELA. Others which include FARO 20, NGB 00779 and FARO 31 had 6.072 mg kg-1. Genotypes N/ ALOGANI, FARO 38 and NGB 00794 recorded 5.952 mg kg-1. FARO 65 was the next genotype with 4.250 mg kg-1. This was followed by NGB 00827, FARO 51(CASIDANE), and FARO 49 which possessed 4.239 mg kg-1. Next to these were FARO 66 and NGB 00786 with 4.218 mg kg-1. N/ATIME-EJU, NGB 00789, N/MAI-ALURI INJ., N/DOGO-BURI and N/TUDU GAMBO were the next Fe-rich genotypes with 4.196 mg kg-1. This was followed by 4.185 mg kg-1 recorded in FARO 16, NGB 00773 and FARO 33. Also, FARO 63 and FARO 22 recorded 4.175 mg kg-1 while the least in this category were NGB 00791 and N/JANKARA with 4.164 mg kg-1. The remaining genotypes recorded less than 2.0 mg kg-1.

Similarly, Table 2 presented the results of zinc content which also exhibited wide variability among the various genotypes with NGB 0079 appearing the best with 6.697 mg kg-1 while N/CHINA CARGO had the lowest zinc of 1.506 mg kg-1. N/MAI-ALURI INJ with 6.187 mg kg-1 recorded the second highest zinc content. Both FARO 49 and N/TUDU GAMBO recorded 6.159 mg kg-1 while FARO 63, FARO 16, NGB00773 and N/ATIME-EJU had 6.130 mg kg-1. FARO 33 recorded 6.101 mg kg-1 followed by FARO 66 with 6.043 mg kg-1. Others include FARO 51 and NGB 00827 containing 6.014 mg kg-1 and were followed by N/DOGO-BURI and NGB 00789 with 5.957 mg kg-1. FARO 65 recorded 5.928 mg kg-1 which was the same recorded in NGB 00786. FARO 22 recorded 5.813 mg kg-1 while N/JANKARA had 5.553 mg kg-1. The remaining genotypes recorded values below 2.2 mg kg-1 and appeared not good enough to develop zinc-dense varieties.

Discussions

The results of the screening indicated the existence of variability in Fe and Zn concentration in the various rice genotypes examined. Both the released varieties and landraces have a fair amount of these micronutrients even though the location of these elements in the grain is not determined by this study.

Most of the old and unpopular varieties, as well as landraces, were found to contain an appreciable amount of Fe and Zn. This corroborates the report published by Aladejana and Faluyi (2007) that wild varieties of the crop are a reservoir of desirable traits exploitable for yield and other genetic improvement purposes. NGB 00782 and FARO 27 are loaded with Fe (6.675 mg kg-1) while NGB 00791 and FARO- 49 are Zn dense containing 6.697 mg kg-1 and 6.159 mg kg-1 respectively.

On the other hand, the majority of the released and commercially cultivated varieties such as

FARO-44, FARO-52, and FARO-67 contained a very low amount of Fe and Zn. This could probably be attributed to the fact that yield and resistance to biotic and abiotic stresses are the prominent breeding target in sub-Saharan Africa to cater for the food needs of the ever-increasing population despite the nutritional quality. High stability indicated by low Standard Deviation (SD) formed part of the basis for the selection of best genotypes.

It was also observed that Fe and Zn exhibited a positive correlation because most of the varieties that possess low iron also have low zinc content. This agreed with the findings reported by Karen *et al*. (2013) that deficiency of iron and zinc is believed to occur concurrently in the human body.

Table 1: Iron (Fe) content of 61 rice genotypes

S/NO	Genotypes	Grain Fe ($mgkg^{-1}$)	SD	S/NO	Genotypes	Grain Fe ($mgkg^{-1}$)	SD
1	FARO 4	1.735	0.0001	32	FARO 67	1.494	0.0001
2	FARO 15	0.410	0.0150	33	NCRO 48	1.494	0.0020
3	FARO 16	4.185	0.0007	34	NGB 00773	4.185	0.0008
4	FARO 17	1.614	0.0037	35	NGB 00775	6.193	0.0003
5	FARO 19	6.193	0.0001	36	NGB 00777	1.735	0.0003
6	FARO 20	6.072	0.0002	37	NGB 00778	1.494	0.0007
7	FARO 21	5.952	0.0004	38	NGB 00779	6.072	0.0004
8	FARO 22	4.175	0.0008	39	NGB 00781	0.289	0.0204
9	FARO 24	1.735	0.0002	40	NGB 00782	6.675	0.0003
10	FARO 27	6.675	0.0010	41	NGB 00783	0.771	0.0132
11	FARO 31	6.072	0.0002	42	NGB 00784	1.494	0
12	FARO 32	0.892	0.0125	43	NGB 00786	4.218	0.0020
13	FARO 33	4.185	0.0009	44	NGB 00789	4.196	0.0004
14	FARO34	1.494	0.0002	45	NGB 00791	4.164	0.0003
15	FARO 37	1.373	0.0001	46	NGB 00794	5.952	0.0007
16	FARO 38	5.952	0.0005	47	NGB 00827	4.239	0.0002
17	FARO 41	1.494	0.0026	48	NGB 00887	1.494	0.0006
18	FARO 44 (SIPI)	1.614	0.0001	49	THAI JEMEELA	6.079	0.0005
19	FARO 45	0.048	0.0206	50	N/ ATIME-EJU	4.196	0.0003
20	FARO 49	4.239	0.0011	51	N/GORKOCHA	1.012	0.0093
21	FARO 51 (CASIDANE)	4.239	0.0005	52	N/MAI-ALURI INJ	4.196	0.0005
22	FARO 52	1.373	0.0002	53	N/ TUDU GAMBO	4.196	0.0007
23	FARO 56 (NERICA-2)	1.253	0.0044	54	N/ CHINA CARGO	1.735	0.0004
24	FARO 57 (TOX 4004)	1.735	0.0002	55	N/ DOGO-BURI	4.196	0.0006
25	FARO 58	0.892	0.0088	56	N/ BIDA ALASKA	1.494	0.0006
26	FARO 61	1.614	0.0004	57	N/ JANKARA	4.164	0.0008
27	FARO 62	1.494	0.0046	58	N/ ALOGANI	5.952	0.0003
28	FARO 63	4.175	0.0006	59	T/YAR ADIZA	1.614	0.0005
29	FARO 64	1.012	0.0090	60	T/ YAR-MAS	1.253	0.0081
30	FARO 65	4.250	0.0004	61	T/ CD	1.614	0.0006
31	FARO 66	4.218	0.0005				

SD = Standard Deviation

Table 2: Zinc (Zn) content of 61 rice genotypes

S/NO	Genotypes	Grain Zn ($mgkg^{-1}$)	SD	S/NO	Genotypes	Grain Zn ($mgkg^{-1}$)	SD
1	FARO 4	1.678	0.0040	32	FARO 67	1.920	0.0059
2	FARO 15	2.052	0.0005	33	NCRO 48	1.839	0.0036
3	FARO 16	6.130	0.0030	34	NGB 00773	6.130	0.0047
4	FARO 17	1.839	0.0025	35	NGB 00775	1.698	0.0047
5	FARO 19	1.759	0.0045	36	NGB 00777	1.708	0.0033
6	FARO 20	2.082	0.0022	37	NGB 00778	2.092	0.0018
7	FARO 21	1.971	0.0044	38	NGB 00779	1.991	0.0030
8	FARO 22	5.813	0.0030	39	NGB 00781	1.870	0.0034
9	FARO 24	1.829	0.0048	40	NGB 00782	1.688	0.0014
10	FARO 27	1.546	0.0019	41	NGB 00783	1.759	0.0040
11	FARO 31	2.052	0.0016	42	NGB 00784	2.112	0.0036
12	FARO 32	1.678	0.0030	43	NGB 00786	5.928	0.0056
13	FARO 33	6.101	0.0024	44	NGB 00789	5.957	0.0042
14	FARO34	2.102	0.0015	45	NGB 00791	6.697	0.0032
15	FARO 37	2.082	0.0005	46	NGB 00794	1.981	0.0010
16	FARO 38	2.072	0.0022	47	NGB 00827	6.014	0.0054
17	FARO 41	1.849	0.0032	48	NGB 00887	1.890	0.0048
18	FARO 44 (SIPI)	1.708	0.0048	49	THAI JEMEELA	2.092	0.0006
19	FARO 45	1.637	0.0030	50	N/ ATIME-EJU	6.130	0.0055
20	FARO 49	6.159	0.0022	51	N/GORKOCHA	1.627	0.0011
21	FARO 51 (CASIDANE)	6.014	0.0048	52	N/MAI-ALURI INJ	6.187	0.0028
22	FARO 52	2.041	0.0056	53	N/ TUDU GAMBO	6.159	0.0029
23	FARO 56 (NERICA-2)	1.546	0.0019	54	N/ CHINA CARGO	1.506	0.0002
24	FARO 57 (TOX 4004)	1.860	0.0043	55	N/ DOGO-BURI	5.957	0.0036
25	FARO 58	2.041	0.0036	56	N/ BIDA ALASKA	2.092	0.0047
26	FARO 61	1.870	0.0049	57	N/ JANKARA	5.553	0.0031
27	FARO 62	1.587	0.0020	58	N/ ALOGANI	1.971	0.0005
28	FARO 63	6.130	0.0009	59	T/YAR ADIZA	1.900	0.0025
29	FARO 64	1.597	0.0037	60	T/ YAR-MAS	1.617	0.0014
30	FARO 65	5.928	0.0041	61	T/ CD	1.951	0.0028
31	FARO 66	6.043	0.0034				

SD = Standard Deviation

Conclusion

Since the majority of the resource-poor farm families who grow and rely solely on commercial varieties (FARO- 44, FARO-52 and FARO- 67) as their staple food might be deficient in iron and zinc, NGB 00782, FARO 27, NGB 00791 and FARO- 49 could be exploited to fortified the deficient commercial lines via hybridization to boost their economic and nutritional benefits. Field trials are also recommended on some landraces such as N/TUDU GAMBO and N/MAIALURI INJECTION that showed an appreciable amount of iron and zinc for genetic purity and further improvement.

References

Aladejana, F & Faluyi J. O. (2007). Agro-botanical characteristics of some West Africa Indigenous Species for a Genome Complex of the Genus *Oryza* Linn. *International Journal of Botany*, 3, 229-239.

Black, R. E., Victora, C. G., Walker, S. P., Bhutta, Z. A., Christian, P & de Onis, M. (2013). Maternal and child under nutrition and overweight in low-income and middle-income countries. *Lancet*. 382, 427–451.

Garcia-Oliveira, A. L., Chander, S., Ortiz, R., Menkir, A., & Gedil, M. (2018). Genetic Basis and Breeding Perspectives of Grain Iron and Zinc Enrichment in Cereals. *Frontier in plant science*. doi: 10.3389/fpls.2018.00937.

Graham, R. D., Knez, M & Welch, R. M. (2012). How much nutritional iron deficiency in humans globally is due to an underlying zinc deficiency? *Advances in Agronomy*. 115,1–40. 10.1016/B978-0-12-394276-0.00001-9.

Karen, H. C., Lim, L. J., Riddell, C. A., Nowson, A. O. B & Ewa, A. S. (2013). Iron and Zinc Nutrition in the Economically Developed World: A Review. *Nutrients; 5*, 3184-3211.

Mallimar, M., Surendra, P., Patil, B., Satish, T. N., Jogi, M & Hundekar, R. (2017). Study the inheritance of Iron and Zinc in segregating population of rice (*Oryza sativa* L.). *International Journal of Pure and Applied Bioscience.* 5 (5): 888-892.

Swamy, B. P. M., Descalsota, G. I. L., Nha, C. T., Amparado, A., Inabangan-Asilo, M. A., Manito C. (2018). Identification of genomic regions associated with agronomic and biofortification traits in DH populations of rice. *PLoS ONE* 13(8): e0201756. https://doi.org/10.1371/journal. pone.0201756.

89 EFFECT OF FRUIT AND MOTHER-PLANT AGES ON THE VIABILITY AND LONGEVITY OF OKRA (*Abelmoschus esculentus* L. Moench) SEEDS

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Abstract

The study was carried out to determine the effect of fruit and mother-plant ages on the viability and longevity of okra (Abelmoschus esculentus L. Moench) seed. Mass planting experiment for seed production was carried out at the teaching and research farm of The Federal Polytechnic, Bida, Niger State, Nigeria, during the 2021 rainy season. The experiment consisted of two varieties of okra and nine fruit harvesting stages at different days after anthesis (DAA), which gives 2x9 treatment combinations arranged in completely Randomized Design (CRD) and replicated four times. Data were collected on the mother-plant ages at harvest on the quality of okra seed, based on seed moisture content, 100-seed weight, fruit length, number of fruits per plant, plant height, leave area, seed colour, fruit weight, seed germination test. Data collected were subjected to analysis of variance (ANOVA) using mini tab version 19 and means were separated using turkey test at 5% level of probability. The results indicated that okra seeds are influenced by age of the fruit. Also, that timing of harvest is an important factor since both early and late harvest reduces seed quality. It is concluded that okra fruit age should be considered in okra seed viability.

Keywords: Fruit, Mother-plant, okra, seed, viability

INTRODUCTION

Okra (*Abelmoschus esculentus* L.), belonging to the family *Malvaceae*, is commonly known as Lady's finger, as well as by several vernacular names, including okra, in the different geographical regions of its cultivation (Abd Elmoneim, 2021). Okra is believed to have originated near Ethiopia, where it was frequently cultivated by the Egyptians during the 12th century, and thereafter spread throughout the Middle East and North Africa (Kumar *et al.*, 2013). Okra is an annual shrub that is cultivated mostly within tropical and subtropical regions across the globe and represents a popular garden crop, as well as a farm crop. It is a widely cultivated vegetable crop and is globally known for its palatability (Yuennan *et al.*, 2014). The immature green pods of okra are usually consumed as vegetables, while the extract of the pods also serves as a thickening agent in numerous recipes for soups, as well as sauces, to augment their viscosity (Archana *et al.*, 2015). Another noteworthy application of okra fruit is their wide use in the pickle industry. The polysaccharides present in okra are used in sweetened frozen foods such as ice creams, as well as bakery products, due to their health benefits and longer shelf-lives (Islam, 2019). Historically, okra pods were utilized for various purposes, such as in food, appetite boosters, astringents, and as an aphrodisiac (Durazzo *et al.*, 2018). Furthermore, okra pods have also been recommended to cure dysentery, gonorrhea, and urinary complications (Durazzo *et al.*, 2018). They are important source of oil and protein.

Seed longevity is a measure of how long seeds can be stored and remain viable under a given set of conditions. Seed longevity in storage varies greatly among species (Hay *et al*., 2011) and is also determined by the cumulative effect of environment during seed maturation and harvesting. Several studies describe the relative longevity of seeds in medium- and long-term gene bank storage (Ellis *et al*., 2018).

There are several factors that can affect the viability and longevity of seeds after harvest, including: ageing, improper storage methods, high temperature during drying, rapid drying or over drying, initial quality of seeds before storage such as fruit and plant ages during seed harvest.

Use of poor-quality seeds (poor quality of farmer saved seeds) is one of the factors responsible for low yield on farmer's field. Poor quality seed results in poor germination and poor crop stands which is significant factor affecting okra productivity. Proper and uniform stand establishment are the key factors for successful crop production in all cropping systems. To ensure such stand, even under adverse conditions, high quality seed must be planted.

Seed quality and quantity are affected by maternal identity (Farzi and Bigloo, 2010), such as maternal age (Birhanu, 2010) and maternal environment (Mathewos, 2012), which will influence the natural regeneration processes. Mother-plant and fruit ages have significant effect on seed quality.

With increasing awareness of health benefit of okra and the role it plays in pharmaceutical industries, the demand for okra is on the rise. Thus, to increase the productivity of okra to meet the increasing demand, it is important to plant high quality seeds of okra. The results emanating from this study will provide farmers with information on the fruit and mother-plant ages at which the best quality seeds can be obtained. Therefore, the objective of this study was to determine the best okra fruits harvesting stage to obtain high quality seed for the two different okra seeds variety.

MATERIALS AND METHODS

Mass planting for seed production was carried out at the teaching and research farm of The Federal Polytechnic, Bida (Latitude 9^{o} 51 N and Longitude 6^{o} 44 E) during the 2021 rainy season. The site

is located in the southern Guinea savannah ecological zone of Nigeria. Annual rain fall distribution is between April and early October with the peak around August.
Average rainfall in this area is 120 mm while temperature ranges from 35 ^{o}C to 40 ^{o}C, the relative humidity is between 40 to 60 % around January, which later increases to between 60 to 80% towards July.

The seeds of the two varieties were sourced from National Horticultural Institute (NIHORT) Ibadan. The experiment consisted of two varieties of okra and nine fruit harvesting stages at (14, 21, 28, 35, 42, 49, 56, 63, and 70) days after anthesis (DAA). Which resulted in 18 (2 × 9) treatment combinations fitted into completely Randomized Design (CRD) and replicated four times. The field were cleared of vegetation and other debris and an area of 50m x 50m was marked out for ridges. Two seeds of okra were sown on manually constructed ridges. Thinning was done two weeks after sowing leaving one per stand. Manual weeding was done at two weeks after planting and subsequently as found necessary. NPK fertilizer were applied (20:15:15) at 200 kg/ha at the rate of 60 kg N, 30 kg P and 10 kg K at four weeks after sowing.

Date tagging of fruit from position 1-3 on the mother-plant were carried out on daily bases as the flowers open. Fruits that developed from the tagged flower were harvested at 14, 21, 28, 35, 42, 49, 56, 63, and 70 days after anthesis (DAA). The seeds extracted from the two varieties and 9 harvested fruit ages were stored in an oven at 37^{o} C and 75 % relative humidity to accelerate the ageing process of the seeds.

100- Seed weight (g)

One hundred seeds were counted at random from the harvested produce of each treatment combinations in four replicates, weighed using Mettler balance and their mean weight was recorded in grams. Data were collected on germination percentage, germination rate index and germination index. Germination percentage was done by counting four replicates of 50 seeds each of the treatment combinations and placed on a water-moistened filter paper. Germination counts were taken at every-other-day. The incubation period was 28 days, and the results were expressed in percentages.
Germination rate index (GRI) and germination index (GI) were calculated and seed leachate electro- conductivity measured as indices to determined seed vigour during the storage periods.

Germination rate index (GRI) shows the percentage of germination per day. This was calculated using the relationship developed by Esechie (1994). Germination index is a comprehensive vigour measuring parameter which combines both germination percentage and speed (speed, duration, high and low events).

Electro-conductivity test

The electro-conductivity test was done by counting four replicates of 50 seeds from each of the treatments into beakers to which 30 ml of distilled water was added. The seeds were left in water for 24hours after which the mixture was stirred and the supernatant decanted into clean beaker (ISTA, 2006) the electro-conductivity of the supernatant was measured using jenway DDS-307 Conductivity meter. The values were expressed in siemens per meter(sm^{-1}). Data in percentages were transformed to arc sin values in order to obtain a reliable interaction between treatments before they were analysed.

The data collected were subjected to analysis of variance (ANOVA) using mini tab statistical package version 19 and means were separated using turkey test at 5% level of probability.

RESULTS AND DISCUSSION

The experiment revealed that okra seeds are influenced by age of the fruit. Table 1 shows the effect of fruit ages at harvest on the viability of okra seeds. sharp increase in seed germination percentage, germination rate index and also germination index from 28, 53, 42, 49, 56, 63 and 70 (DAA) The seeds harvested at 14 and 21 (DAA) were not viable and no germination, with L.D 88 germinating significantly than variety NHAe47-4 in all viability test. The increase in germination percentage, germination rate index (GRI) and germination index (GI) with increase in maturity could be attributed to greater inflow of assimilate with progress in seed maturation as reported by Chen et al. (2009), Kavak et al. (2012) that timing of harvest is an important factor since both early and late harvest reduces seed quality.

Table 1. Effect of fruit ages at harvest on the viability of okra seeds

Treatment	Parameters		
Varieties (V)	G.P (%)	GRI (% day-1)	GI (%)
NHAe47-4	22.50b	1.98b	56.64b
L.D 88	24.62a	2.50a	92.88a
S.E ±			
Fruit age (DAA)			
14	0.00e	0.00e	0.00e
21	0.00e	0.00e	0.00e
28	45.13c	0.10d	7.98d
35	77.92b	0.52c	26.60c
42	79.04b	0.98c	52.50b
49	80.30a	1.68b	76.50b
56	83.82a	1.80b	89.25a
63	85.50a	2.00a	91.50a
70	91.61a	2.20a	92.70a
SE±			

Key: V= Variety, GP= Germination percentage, GRI= Germination rate index, GI= Germination index

CONCLUSION

It is concluded in this research that okra fruit age should be considered in okra seed viability. This is because age of okra fruit is a major determinant of okra seed quality. Therefore, both the early and late harvest could result to low quality of okra seed.

REFERENCES

Abd Elmoneim, (2021). A review on *Abelmoschus esculentus*. Pharmacia 2021, 1, 84–89. (Google Scholar).

Archana, G. Babu, P.A.S.; Sudharsan, K.; Sabina, K.; Raja, R.P.; Sivarajan, M.; Sukumar, M. (2015*). Evaluation of Fat Uptake of Polysaccharide Coatings on Deep-Fat Fried Potato Chips by Confocal Laser Scanning Microscopy. Int. J. Food Prop.* 2015, 19, 1583–1592.

Birhanu, B. (2010). Assessment of Bread Wheat Production, Marketing and Selection of N Efficient Bread Wheat (*Tritium aestivum* L.) Varieties for Higher Grain Yield and Quality in North Western Ethiopia. MSc. Thesis, Haramaya University, Haramaya, Ethiopia.

Chen, G. Q., Vang, L. & Lin, J. (2009). Seed Development in *Lesquerel lanfendleri* (L.). *HortScience*. 44(5): 1415-1418

Durazzo, A., Lucarini, M., Novellino, E., Souto, E. B., Daliu,and P., Santini, A. (2018). Bioactive Components' Beneficial Properties-Focused on Antidiabetic Role-For Sustainable Health Applications. Molecules 2018, 24 - 38.

Ellis, R. H., Hong, T. D and Linington S, (2018). Seed storage behavior: a compendium. Handbooks for gene banks: No. 4. International Plant Genetic Resources Institute, Rome, Italy.

Farzi A, and Bigloo B. S. M. (2010). Evaluation of genetic diversity of wheat lines by for related traits to drought tolerance. The 11th Iranian Congress of Agronomy Science and Plant Breeding, pp: 155-157.

Hay, F. R., Probert, R. J. (2011). Chapter 20: collecting and handling seeds in the field. Pages 1–8. In: Guarino L, Goldberg E (eds) Collecting plant genetic diversity: technical guidelines, 2011 update. Bioversity International, Rome, Italy.

Islam, M. T. (2019). Phytochemical information and pharmacological activities of Okra (*Abelmoschus esculentus*): A literature-based review. Phyto her. Res. 2019, 33, 72–80.

Kavak, S., Ilbi, H., Eser, B., Powell, A. A. & Matthews, S. (2012). Effects of Seed Moisture Content and Threshing Methods on Bean (*Phaseolus vulgarisL.*) seed Quality. *Suleyman Demirel Universitesi Ziraat Fakultesin Dergisi*, 7 (1), 51-57.

Kumar, A., Kumar, P.and Nadendla, R. A. (2013*). review on: Abelmoschus esculentus (Okra). Int. Res. J. Pharm. Appl. Sci*. 2013, 3, 129–132. (Google Scholar)

Mathewos, A, Tewodros M, and Yasin, G. (2012). *Participatory on-farm evaluation of improved bread wheat technologies in some districts of southern Ethiopia. J Biol Agri Healthcare* 2(4): 85-91.

Yuennan, P., Sajjaanantakul, T. and Kung, B. (2014). *Effect of Okra Cell Wall and Polysaccharide on Physical Properties and Stability of Ice Cream. J. Food Sci*. 2014, 79, E1522–E1527.

92 INFLUENCE OF TEMPERATURE AND AIR VELOCITY ON THE MOISTURE DIFFUSIVITY AND ACTIVATION ENERGY IN DRYING OF AFRICAN YAM BEAN (Sphenostylis stenocarpa) TUBER

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Abstract

The aim of this paper is to report African yam bean tuber moisture diffusivity data determined and activation energy from experimental drying kinetics. The thin-layer drying experiments were carried out under three air temperatures of 50, 60 and 70 ºC, two air velocity 1.2, and 1.8 m/s at constant length thickness of 3 mm. It was observed that drying took place in the falling rate period. Effective moisture diffusivity values varied from 2.55×10^{-9} m^2s^{-1} to 4.92×10^{-9} m^2s^{-1} for the range of temperatures considered. The values of activation energy ranged between 10.0059 and 8.098 kJ/mol were obtained at different velocities of air.

Keywords: African yam bean tuber, Drying, Effective moisture diffusivity, Activation energy

Introduction

African yam bean (AYB*; Sphenostylis stenocarpa*) is a tuberous legume which belongs to the family Fabaceae. It is also known as *Okpududu* and *Azanma* (Igbo, Nigeria), *Girigiri* (Hausa, Nigeria) and *Sese* (Yoruba, Nigeria). Nigeria is more prominent for AYB production, as it is extensively cultivated in the western, eastern, southern and northern states of the country (Saka *et al*., 2004). AYB is mostly cultivated as a mixed crop with cassava, vegetables, yam and rice.

Generally, African yam bean is grown for tubers in certain areas and for seeds in other locations, and evidence that yield of seeds and tubers are inversely related (Ene-Obong and Okoye, 1992).

The edible tubers look like elongated sweet potatoes are harvested from 150 to 240 days after sowing (Ezueh, 1984).

African yam bean is one of the under-utilize African crop species that has immense advantages, especially its high nutritional value (it has a total carbohydrate of 61.6%, 19.1% crude protein, 0.5% crude fat, 5.2% crude fibre and 2.4% total ash (Amoatey et al., 2000).

The tuber of AYB has a protein content that is more than twice that obtainable in sweet potato or Irish potato (NRC, 2007). It is also higher than those in yam and cassava (Amoatey, 2000).

Drying is one of the oldest method of preserving food (Krzysztof *et al.*, 2020). Maxwell and Zantoph (2002) define drying as a mass transfer process consisting of the removal of moisture from a solid, semi-solid or a liquid. It is also a method of food preservation that works by removing water from the food, which inhibits deterioration (Zantoph and Schuster, 2004). It helps in reducing the water activity of the produce to a level below which deterioration does not occur for a definite duration. Drying of moist materials is a complicated process involving simultaneous heat and mass transfer. Many researches have attempted food product drying process especially perishable crops. Mathematical modelling of drying process is a good way to analyse and describe the products drying treatment.

Many authors have studied the drying behaviour of food materials and several mathematical models have been proposed. There appears to be little information in the literature on the drying characteristics of AYB tuber and the combined effects of temperature and air velocity.

The knowledge of the moisture diffusivity and activation energy under different drying conditions is essential in optimizing the process of drying food and agricultural materials. This study therefore, investigated the effects of temperature and air velocity on the effective moisture diffusivity and activation energy during the drying of African yam bean tuber.

Materials and Methods

AYB tuber were purchased from a local market in Minna, Niger State, washed with water, manually peeled, re-washed and sliced into chips 3mm thickness) using sharp stainless steel knife. Drying experiments were performed using three different temperature levels (50, 60 and 70^{o}C) at 1.2ms^{-1} and 1.8ms^{-1} drying air velocity in a fluidized bed dryer at laboratory scale. During drying experiments, the weight of the sample was measured with a digital balance and recorded at thirty minutes interval for all temperature range selected for this study until no further changes in their mass were observed (constant weight). The digital top pan balance was kept very close to the drying unit (within 1 m). Each process of weight measurement lasted about 9.55±0.31 seconds. Moisture contents of the samples at each weighing intervals were determined according to standard method by AOAC, 2005. Drying experiment for each temperature was conducted in triplicate, and mean values were reported.

Mathematical modelling of AYB tuber

The moisture ratio (MR) of AYB tuber during the drying process was obtained following Equation 1.

$$MR = \frac{M_t - M_e}{M_o - M_e} \quad (1)$$

Where M_t, M_o and M_e are moisture content at each measurement time, initial moisture content, and equilibrium moisture content (kg water/kg dry matter) respectively. However, the drying varied continuously during the drying experiments, the relative moisture content of drying air is simplified into Equation 2 (Akpinar et al., 2003):

$$MR = \frac{M_t}{M_o} \qquad (2)$$

Determination of the effective moisture diffusivity (D_{eff})

The AYB was assumed as a slab because the thickness of sample was much less than its diameter. The effective moisture diffusivity was calculated by the following equation:

$$MR = \frac{8}{\pi^2}\sum_{n=0}^{\infty}\frac{1}{(2n+1)}\exp\left(-\frac{(2n+1)^2\pi^2 D_{eff}t}{4L^2}\right) \qquad (3)$$

Many researchers demonstrated that for long drying period, Equation 3 can be further simplified to the first term of series as follows (Tutuncu and Labuza, 1996):

$$MR = \frac{8}{\pi^2}\exp\left(-\frac{\pi^2 D_{eff}t}{4L^2}\right) \qquad (4)$$

Equation 4 can be arranged in a logarithmic form as follows

$$\ln MR = ln\frac{8}{\pi^2} - \frac{\pi^2 D_{eff}t}{4L^2} \qquad (5)$$

The effective moisture diffusivities are typically determined by plotting experimental drying data in terms of ln(MR) versus time t.

Diffusivities are typically determined by plotting experimental drying data in terms of ln MR versus drying time (t), because the plot gives a straight line with a slope as follows:

$$\text{Slope} = \frac{\pi^2 D_{eff}}{4L^2}t \qquad (6)$$

where t is the time (s), D_{eff} is the effective diffusivity (m^2s^{-1}) and L is the half thickness of samples (m).

Calculation of activation energy

The temperature dependence of the effective diffusivity may be described by an Arrhenius-type relationship (Wang et al., 2007) as follows:

$$D_{eff} = D_o\exp\left(-\frac{E_a}{RT_a}\right) \qquad (7)$$

where D_0 is the pre-exponential factor of the Arrhenius equation (m^2s^{-1}), Ea the activation energy (kJ/mol), R the universal gas constant (kJ/mol K) and T the absolute temperature (K).

$$\text{Slope} = \frac{E_a}{T} \qquad (8)$$

From the slope of the straight line of ln D_{eff} versus reciprocal of T, described by the Arrhenius equation, the activation energy, E_a, could be calculated.

Results and Discussion

Table 1: Effective moisture diffusivity and activation energy for AYB tuber slices

Dry air velocity (ms^{-1})	Temperature (^oC)	Effective moisture diffusivity($\times 10^{-9}$ m^2s^{-1})	Activation energy($kJmol^{-1}$)
1.2	50	2.55	10.0059
	60	2.74	
	70	3.01	
1.8	50	4.01	8.098
	60	4.47	
	70	4.92	

The effective moisture diffusivity of a food material characterizes its intrinsic moisture mass transport property that includes molecular diffusion, liquid diffusion, vapour diffusion, hydrodynamic flow and other possible mass transport mechanisms (Karathanos *et al*., 1990). The effective moisture diffusivity was calculated using Equation 7. The minimum value of the moisture diffusivity was 2.55×10^{-9} m^2s^{-1} at the air velocity of 1.2 ms^{-1} and air temperature of 50°C while the maximum value of the moisture diffusivity was 4.92×10^{-9} m^2s^{-1} at the air velocity of 1.8 ms^{-1} and air temperature of 70°C. These values are in good agreement with the most recent reported values of 2.03×10^{-9} to 1.71×10^{-9} m^2s^{-1} for olive-waste cake (Vega-Galvez et al., 2010). 1.7×10^{-10} to $1.15\times10^{-9}m^2s^{-1}$ for apricots (Mirzaee et al., 2009). Generally, the value of effective moisture diffusivity changes in the range of 10^{-11} to 10^{-9} m^2s^{-1} for food materials (Babalis and Belessiotis, 2004).

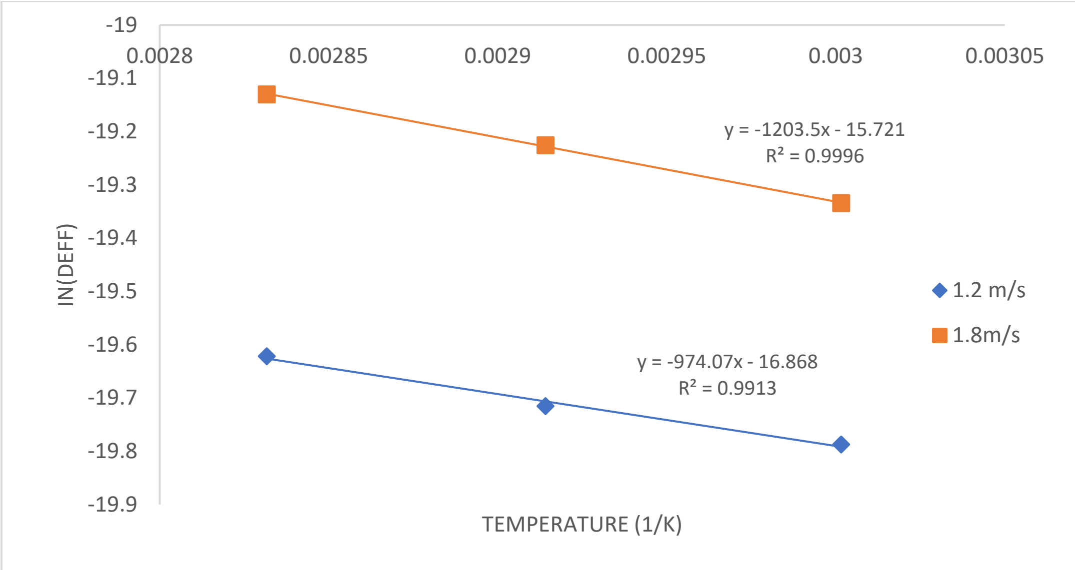

Figure 1: Relationship between effective coefficient moisture diffusivity and temperature for 1.2 and 1.8 m/s^2 air velocity.

Figure 1 shows the relations between the natural logarithm of D_{eff} and the reciprocal of absolute temperature for drying of the sliced AYB tuber. The results showed a linear relationship derived from the Arrhenius-type equation. According to the slopes of two straight lines, the values of activation energy were 10.0059 and 8.098 kJ/mol for 1.2 and 1.8 m/s^2 drying air velocity. The values obtained is however lower when compared with the value (16.98 kJ/mol) reported by Tai *et al*. (2021) for banana. The differences observed could have resulted from the higher temperature used in their study.

Conclusion

The effects of temperature and drying air velocity on the effective moisture diffusivity and activation energy of AYB tuber have been investigated in this study. Variations in temperature and drying air velocity levels had significant effect on the effective moisture diffusivity and activation energy of AYB tuber. Effective moisture diffusivity values varied from 2.55×10^{-9} m^{2}s^{-1} to 4.92×10^{-9} m^{2}s^{-1}, which increased with increase in temperature and drying air velocity. The values of activation energy ranged between 10.0059 and 8.098 kJ/mol. Ea values were found to decreased slightly with increase in drying air velocity.

References

Akpinar, E. K., Bicer, Y. and Yildiz. C. (2003). Thin layer drying of red pepper. *Journal of Food Engineering*, 59(1): 99–104.

Amoatey, H.M. (2000). The African Yam Bean: A Neglected Crop in Ghana. *Biotechnology and Nuclear Agriculture Research Institute Journal*, 6(1) 74-77.

AOAC (Association of Official Analytical Chemists). (2005). Official methods of analysis of the Association of Analytical Chemists International. USA: AOAC.

Babalis J., Belessiotis V.G. (2004). Influence of the drying conditions on the drying contents and moisture diffusivity during the thin layer drying of figs. *Journal of Food Engineering*, 65(3): 449-458.

Ene-Obong E.E and Okoye F.I (1992). Interrelationships between yield and yield composition African yam bean. *Tropical Land Wirstschaft Vet. Med.* 30(3): 283-290.

Ezueh, M.I (1984) African yam bean as a crop in Nigeria. *World crops*, 36(6): 199-200

Krzysztof, G., Agnieszka, K., and Aneta C. (2020) Suitable model for thin-layer drying of root vegetables and onion. *International Agrophysics Journal*. 34(1): 79-86

Karathanos, V.T., Villalobos, G. and Saravacos, G.D. (1990). Comparison of two methods of estimation of the effective moisture diffusivity from drying data. *Journal of Food Science*, 55(1): 218-231.

Maxwell, E.O and Zantoph, U.B. (2002). Drying effect on food products. 4th edition, CBS publishers, New Delhi.

Mirzaee E., Rafiee S., Keyhani A. and Emam-Djomeh Z. (2009). Determining of Moisture Diffusivity and Activation Energy in Drying of Apricots. *Research in Engineering*, 55(3): 114-120.

National Research Council-NRC (2007) Lost Crops of Africa: Vol II: Vegetables and Yam Bean Development. Security and Cooperation Policy and Global Affairs (DSC), Washington DC, 322-344.

Saka, J.O., Adeniyan N.O, Banji J.O and Ajibade, S.R. (2004). Survey of underutilized grain legume production systems in the Southwest agricultural zone of Nigeria. *J. Agric and Food Info*., 6(3): 93-108.

Tai, N.V., Linh, M.N. and Thuy, N.M (2021). Modelling of thin layer drying characteristics of “Xiem” banana peel cultivated at U Minh district, Ca Mau province, Vietnam. *Food Research*, 5(5): 244 – 249.

Tutuncu M.A. and Labuza T.P. (1996). Effect of geometry on the effective moisture transfer diffusion coefficient. *Journal of Food Engineering*, 30:433–447.

Vega-Galvez A., Miranda M., Diaz L.P., Lopez L., Rodriguez K. and Di Scala K. (2010). Effective Moisture Diffusivity Determination and Mathematical Modelling of the Drying Curves of the Olive-Waste Cake. *Bioresource Technology* 101(19): 7265–7270.

Wang Z, Sun J, Liao X, Chen F, Zhao G, Wu, J. (2007). Mathematical modelling on hot air drying of thin layer apple pomace. *Food research International* 40(1): 39–46.

Zantoph B.C and Schuster U.N (2004). Effect of solar drying on food products. *International Journal of Food Technology*. 27(1): 323-329.

93 PROFILING OF SOYBEAN (*Glycine Max* (L.) GENOTYPES WITH HIGH FUNCTIONAL OIL CONTENT FOR INDUSTRIAL AND DOMESTIC APPLICATIONS

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Abstract
Globally, bio-based industrial and domestic chemical sources are becoming increasingly demanded in the chemicals and materials industries. Soybean oil is produced within the beans (seeds) of soybean plant (Glycine max (L.) as an edible product. With the use of appropriate methods such as crushing and refining processes, soybean oil contains varying degrees of polyunsaturated fatty acids, monounsaturated fatty acids, and saturated fatty acids but depends on the varietal genetic makeup and some environmental factors. The aim of this study was to estimate the oil contents of Twenty-three (23) soybean genotypes to explore their oil contents on comparative bases in order to elucidate their nutritional, pharmaceutical, and medicinal values using standard proximate analytical methods of the Association of Official Analytical Chemists (AOAC, 1999). The results showed the presence of (mean) fat contents ranging from 22.37-31.15%. The presence of high fat contents such as observed in this study means that most of the soybean genotypes used here could be considered as sources of quality raw materials for food (including human and animal) and for pharmaceutical applications.

Keywords: Edible oil, Bio-based, Nutritional, Fat and Genotype

Introduction

Throughout the world, Soybean (*Glycine max* (L.) Merr.) is highly cultivated as an important leguminous crop. It is grown in both the tropical, subtropical, and temperate climates where it provides abundant protein and oil for human diet and animal feed supplements (Wajid *et al*., 2020). The seeds of many varieties of soybean seeds contain on average of about 36% protein, 30% carbohydrates, and appreciable amounts of dietary fiber, vitamins, and minerals. The oil contents of about 20% makes soybean the most important crop for edible oil production. In Nigeria, the seeds of soybean have been used for the preparation of varieties of both dried, fermented and fresh foods. There are many soybean-based food products such as soy milk, soy sauce, tofu, etc that are obtained from soybean during one form of processing or the other for human and animal consumption. Also, soy oil is extracted from the soybean as soy meal which are nutritionally balanced for domestic and industries especially for pharmaceutical product applications and other products such as paint, plastics, paper, inks etc (Arewa *et al*., 2018).

Soya bean oil is highly unsaturated and as such it is hydrogenated in order to produce products such as shortening and margarines by the industrial additions of Hydrogen to the double bonds of the triglycerides in order to increase their respective melting points. The process of Hydrogenation also helps to saturate the partially double bonds in soybean oil which eventually increases the oxidative stability (Rekhadevi and Rajagopal, 2016).

The use of soybean as a feedstock for fatty acids in industries has several advantages. For these reasons, if an industrial fatty acid is the target, and it is not compatible with feed usage, it may be prudent to use an alternative crop whose seeds are not used for animal feed as the host for this trait (Lan *et al*., 2007).

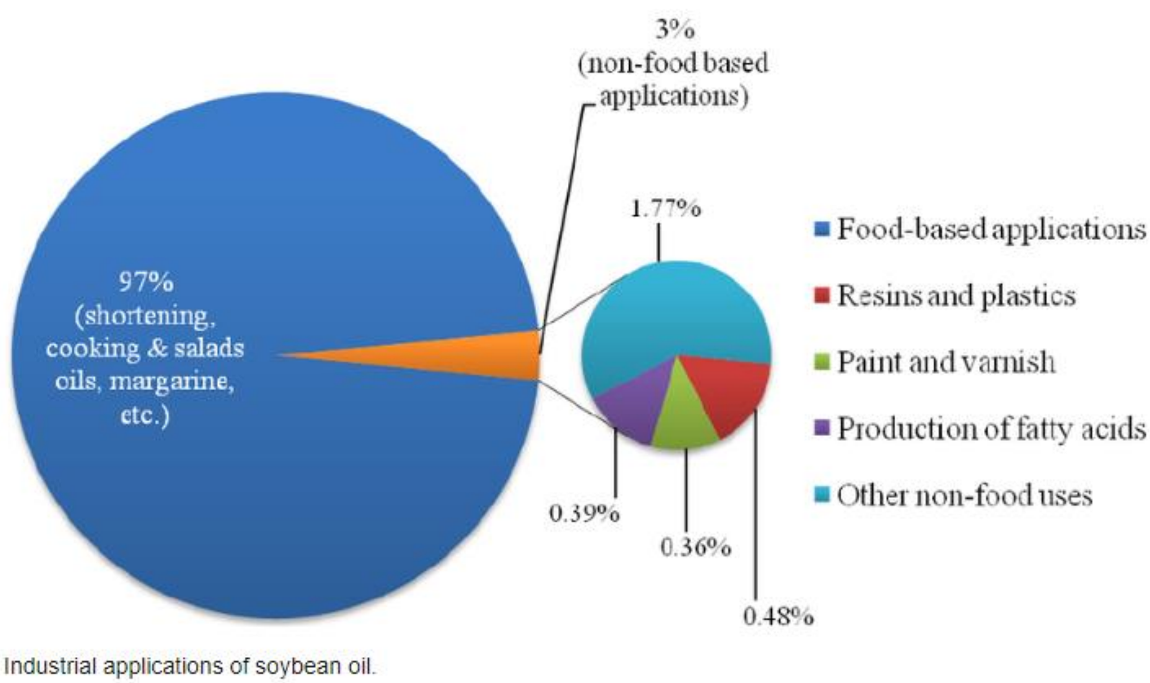

Fig. I: Industrial Applications of Soybean Oil

The presence and possibility of increasing the components of soy oil proportionately using genetic and environmental conditions has been one of the targets for the nutritional improvement of soy oil for higher grade food and feed applications (Javier *et al*., 2022). For instance, it has been reported that soybean oils with enhanced ω-3 fatty acid levels have more value in both food and feed applications. About 85 percent or more of them is further processed into soy oil and soy meal by various means especially through crushin. The meal is mostly used as part of animal feed stock while the oil may either be converted to biodiesel or used domestically as food. However, with the current economic challenges occasioned by Covid-19 and other challenges, the cost of importation has sky rocketed leading hike in the prices of soybean-derived products such as animal feeds and their products. With the knowledge of genetic improvement of soy bean with consequence improved nutrition oil both in quantity and in quality, feedstock for animal and biofuels from soy oil could trigger further research innovations that will stimulate the development of soybean genotypes for higher oil yields in quality and quantity in Nigeria and beyond. Due to the current importance and needs for soybean oil, it is necessary to investigate their proximate chemical composition across various genotypes. Therefore, this study was carried out to estimate the active components especially the total oil content (TFC) across 23 genotypes using standard procedure (AOAC, 1999).

Materials and Methods

This research was conducted in two stages. The first aspect of the experiment involve the cultivation of fifty soybean genotypes under field condition for morpho-agronomic characteristics and the second stage was to assess the genetic variability using the nutritional contents that was analyzed using standard proximate analytical methods such as the Association of Official Analytical Chemists, (AOAC, 1999). The study was designed objectively to estimate the extent of genetic variability of the soybean genotypes.

Sample Collection and Preparation

The soya bean seeds were obtained from the first stage of the experiment which involved growing the seeds of the selected genotypes The obtained seeds were grounded with pestle and mortar and then packed in an air tight container and stored in a desiccator (containing silica gel) and further analysed. All the chemicals that were used were of analytical grade (AOAC, 1999).

Determination of Proximate Composition

The proximate compositions of the grounded soya bean seed were determined using standard analytical methods and were carried out at Kembiz Scientific & Laboratories Nigeria Ltd, Kuje Road, Gwagwalada, Abuja, Nigeria. All measurements were done in triplicates and values presented in percentage (Nancy *et al.*, 2012).

Moisture Content

Two grams (2 g) of the grounded soya bean seed were oven-dried in a crucible at 105 °C for 12 hours. The dried sample were then cooled in a desiccator for 1hr and its constant weight were determined. The percentage loss in weight were expressed as percentage moisture content (Nancy *et al*., 2012).

Ash Content

Ashing was carried out using 2 g of dried milled soya bean seeds in a muffle furnace at 550 °C for 6 hr. The residual ash in the crucible was cooled in a desiccator and weighed. The percentage of residue weighed was expressed as ash content (AOAC, 1999).

Crude Lipid Content

Continuous extraction of lipid was done for 5 hr with petroleum ether in a soxhlet extractor using 2.00 g of the sample to determine the crude lipid content (Udo and Oguwele, 1986).

Crude Protein Content

Kjeldahl method was used to determine total protein. Here 1 g of the sample was placed in a filter paper and introduced into a Kjedahl flask, 10 ml of concentrated H_2SO_4 was added and digested in a fume cupboard until the solution become colorless. The distillation was carried out with 15 ml of 50% of NaOH. The tip of the condenser was dipped into a conical flask containing 6 ml of 4% boric acid in a mixed indicator until a green coloration was observed. Titration was done in the receiver flask with 0.01 M HCl until the solution turned red (Gabriel *et al*., 2018).

Crude Fibre Content

Estimation of the crude fiber was done by acid and alkaline digestion methods in which 2.00 g of each sample was used with 20% H_2SO_4 and NaOH solution (Gabriel *et al*., 2018).

Carbohydrate Content

The carbohydrate content of the sample was then determined by estimation using the arithmetic difference method (De Conto *et al*., 2011; James, 1995) as defined by equation (1). % Carbohydrate = 100 (% Moisture + % Fat + % Ash + % Fibre + % Protein) (Nancy *et al*., 2012).

Results

Table I below shows the general proximate composition of the major constituent of the 23 samples of the soybean genotypes.

Table I: Mean Proximate Composition of the Experimental Soya Bean

Sample ID	Moisture Content (%)	Ash Content (%)	Crude Fat (%)	Crude Fibre (%)	Crude Protein (%)	CHO (%)	Dry Matter	Metabolizable Energy (kj/100g)
SB01	6.69	14.96	27.55	13.13	29.40	8.09	93.12	1665.5
SB02	6.59	12.47	22.37	12.78	39.90	5.90	93.41	1609.5
SB03	6.69	11.05	23.19	13.10	39.21	6.76	93.31	1643.3
SB04	6.54	10.06	26.95	12.82	34.90	8.75	93.46	1745.75
SB05	6.46	11.43	25.43	11.98	36.70	8.00	93.54	1706.65
SB06	6.26	10.11	26.81	15.59	35.50	5.74	93.74	1700.35
SB07	6.19	11.57	24.89	8.48	40.80	8.05	93.81	1772.75
SB08	5.58	09.73	30.20	10.64	36.04	7.81	94.42	1872.05
SB09	6.48	08.62	28.66	12.82	35.3	8.12	93.52	1806.65
SB10	6.42	8.85	28.53	12.09	37.40	6.72	93.58	1813.3
SB11	6.06	10.13	26.26	14.77	35.7	7.09	93.94	1705.5
SB12	5.84	9.12	25.10	13.02	39.10	7.05	94.16	1748.5
SB13	6.21	8.99	24.26	13.66	41.2	5.72	93.79	1698.95
SB14	6.01	10.41	31.15	13.17	33.8	5.47	93.99	1830.8
SB15	5.22	12.12	28.3	10.33	34.99	6.57	94.78	1855.2
SB16	6.06	11.61	26.37	11.84	36.79	7.32	93.94	1731.85
SB17	5.71	12.24	27.76	11.42	72.58	6.58	94.30	1763.55
SB18	5.52	12.17	26.63	13.42	33.71	8.55	94.48	1710.85
SB19	5.22	9.11	30.74	15.00	32.95	6.99	94.78	1826.55
SB20	6.11	11.29	26.9	15.26	33.2	7.28	93.89	1690.05
SB21	6.16	11.28	26.23	14.34	34.02	7.98	93.84	1691.15
SB22	6.42	9.34	29.15	10.61	38.01	6.48	93.58	1842.9
SB23	5.93	10.87	27.78	14.07	33.1	8.25	94.07	1738.9

SB = *Soya Bean*

From the table, the mean value of the soy bean oil (fat) ranges from 22.37 to 31.15% as recorded from samples SB02 and SB14 respectively.

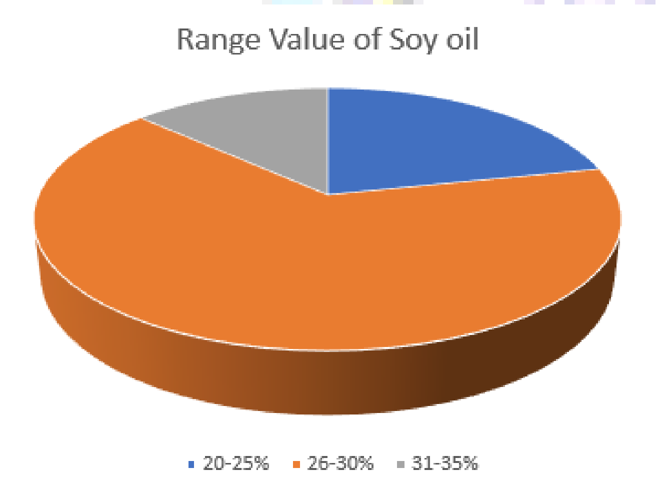

Fig. II: The proportion of soy bean oil within the 23 samples.

The proportion of the oil contents in the twenty-three soy bean samples are distributed in the ranges (%), 20-25; 26-30 and 31-35 and presented in figure II Above. Highest proportion of the soya bean examined had oil content range between 26-30%. While the next had 20-25% and least in the proportion has oil content of 31-35%.

Discussion

Studies have been carried out to evaluate and to show the variation of quality attributes among oils from different soybean varieties, Bovender special, Foster and F-8827 (Farooq *et al*., 2016). The oil content of most soybean reported ranges from 13% to 25%, with a commodity-range of 16% to 23% (Li *et al*., 2013). Our study recorded higher values as indicated above. This implies that the cultivars can be used in many feeds formulation and industrial applications depending on the oil content needed for the particular occasion. For instance, since Bio-diesel fuel for bio-diesel engines are being produced from soybeans through trans-esterification by the removal of glycerin from the oil, the high oil content of many of the cultivars used in this work could be utilized for soy bio-diesel production for clearer burns with reduction of particle emissions, non-toxicity, renew ability, and environmentally-friendliness features (Daming *et al*., 2011). The high oil contents of the soybean also implies that they could be used for industrial production of crayon which according to Tom and Edgar, (2009) could replace the petroleum-based regular crayons making them non-toxic and safer for children. The research report by Ojewumi *et al.* (2019) showed that candles made with soybean oil burn longer, but with less smoke and soot justifying the fact that soybean seeds used in this research could be utilized for similar purpose because of their high oil contents.

According to Farooq *et al*. (2016), soybean oil has a relatively high smoke point of about 450°F (230°C) against the unrefined extra-virgin olive oil of about 375°F (191°C) and canola oil 428–450°F (220–230°C) with the consequence of good option for high-heat cooking like roasting, baking, frying, and saucing, as it can withstand high temperatures without breaking down. Soybean genotype with high oil content gives higher yields of the desirable oil.

Conclusions

The study has revealed that there was variation among the 23 genotypes of soybean evaluated for various levels of oil contents. It was revealed that SB 14, SB 19 and SB 08 has higher level of oil contents of 31.15, 30.74 and 30.20 respectively. The levels of oil content information obtained from the study provide base line information to breeders on improvement of soybean for high oil contents, industries and for Pharmaceutical purposes. It opens opportunities to investigate the grades and qualities of the oil obtained from the research work.

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References

Arewa, J.A., Alor, E.O. and Akpoguma, E. (2018): Extraction of Soya Bean Oil for the Formulation of Oil and Emulsion Paint; *Scientific Research Journal (SCIRJ), Volume VI, Issue XII.*

Association of Official Analytical Chemists (AOAC) (2000). Official Methods of Analysis of AOAC International, 17th ed. AOAC International: Gaithersburg, MD, USA.

Daming, H., Haining, Z and Lin L. (2011): International Conference on Future Energy, Environment, and Materials Biodiesel: an Alternative to Conventional Fuel. *Energy Procedia* 16 (2012), 1874 – 1885.

Farooq, A., Ghulam M. K., Farooq N and Ghulam S. (2016): Variations of quality characteristics among oils of different soybean varieties; *Journal of King Saud University - Science* Feed. 2020.

Gabriel, A. F., Igwemmar, N. C, Sadam, A. A., and Babalola, S. A. (2018): Characterization of Seed Oil from Citrullus lanatus (Watermelon); *Direct Research Journal of Public Health and Environmental Technology; Vol.3 (2), pp 34-40.*

Javier, A. H., Bhawna, S., Maria C. I. and Maria S. P. (2022): Soybean hull pectin and nanocellulose: tack properties in aqueous pMDI dispersions; *Journal of Materials Science 57(8).*

Lan, Y., Williams, B.A., Verstegen, M. W. A., Patterson, R. and Tamminga, S. (2007). Soy oligosaccharides in vitro fermentation characteristics and its effect on caecal microorganisms of young broiler chickens Animal Feed. *Science and Technology 133: 286–297.*

Nancy, J. T., Lawrence, N. and Andy, C. (2012): Determination of Ash in Animal Feed: AOAC Official Method 942.05 Revisited; *Journal of AOAC International 95(5):1392-7.*Nutrition in Ethiopia

Ojewumi, M.E., Olanipekun, O.O., Obanla, O.R., Ojewumi, E.O. and Bassey, R.S. (2019): Production of Candle from Oil Extract of a Legume – Soybean; International Journal of Engineering and Advanced Technology (IJEAT)-ISSN: *2249 – 8958, Volume-9 Issue-2.*

Rekhadevi, P. V. and Rajagopal, S. (2016): Evaluation of the deleterious health effects of consumption of repeatedly heated vegetable oil; *Toxicol Rep. 2016; 3: 636–643.*

Review on the Role Soybean on Animal Feed and Human Sudarić, A., Soybean for Human Consumption and Animal Takele Atnafu Delele

Tom E. C. and Edgar B. Cahoon (2009): Soybean Oil: Genetic Approaches for Modification of Functionality and Total Content; *Plant Physiology . 151(3), 1030–1040.*

Udo, E.J. and Oguwele, J.A. (1986): Laboratory Manual for the Analysis of Soil, Plants, and Water Samples. 3rd Edition, Department of Crop Production, University of Ilorin, Kwara State Nigeria Pp:131-152.

Wajid, A., Muhammed M. A., Fozia I., Moin, Q., Ayhan C. (2020): Nutritive potentials of Soybean and its significance for human health and animal production: A Review; Eurasian Journal of Food Science and Technology 2020; Vol: 4, Issue: 1, pp: 41-53 41.

94 EFFECT OF SEED SIZE AND POSITION OF SEEDS IN POD ON THE SEED VIGOUR OF FLUTED PUMPKIN *(Telfaria occidentalis* Hook)

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Abstract

Selection of high-quality seeds is important for optimum productivity of fluted pumpkin. This study aimed to evaluate the effects of seed position in pod and size of seeds on the vigour of fluted pumpkin seeds. It was a 3 x 3 factorial combination of 3 seed position in pod viz: anterior, middle and posterior section (close to pedicel) and three seed sizes viz: (big, medium and small). These were arranged in completely randomized design with five replicates. Data were collected on number of days to emergence, percentage emergence, emergence rate index. Data collected were subjected to analysis of variance (using Statistical Analysis System SAS) version of 9.2. The results showed that the first emergence count was observed at 7 days after sowing (DAS) in big and medium seeds. Anterior seeds consistently had the highest emergence percentage at 12-19 DAS. Anterior seeds had the highest emergence rate index value statistically similar to the value recorded in the middle seeds. The medium sized seeds had the significantly highest emergence rate index. It can therefore be concluded that medium sized seeds extracted from the anterior and middle position of fluted pumpkin pods has the potential to give more vigorous seedlings in a non-stressed environment.

Keywords: fluted pumpkin, seed quality, seed position, seed size and seed vigour

INTRODUCTION

Seed is a vital element in increasing crop yield and output. Improving seed quality is one of the most affordable and effective agricultural growth inputs since it can considerably increase any crop's potential output (Jerlin and Vadivelu, 2014). Seed is a mature, fertilized ovule that is protected by a seed coat. It is a component of horticultural, sericultural, and silvicultural plants used for sowing. Given its significance in the development of agriculture and agrarian communities, seed quality has always been revered. The early growth and development of a plant is supported by the abundance of protein, carbohydrate, and oil in its seed. Seed vigour is defined as the ability of seed to germinate and establish seedlings rapidly and robustly across diverse environmental condition (Finge-Savage and Bassel, 2016)

Fluted pumpkin (*Telfaria occidentalis*) commonly called 'ugu' is a very important vegetable that is popular in West Africa. It belongs to the family of *cucurbitaceae*. It is a leafy vegetable that produces fruits used for culinary purposes. Due to its nutritional value, it is used to increase the dietary quality of soups (Nwosu *et al.*, 2012; Akanni-John, 2020). The main method of fluted pumpkin propagation is seed. Seed size is a measure of seed qualitythat can affects seedling growth and establishment in crops (Nik *et al*., 2011). Vigor, germination, and seedling establishment are all impacted by seed size. Position of seeds in the pod also affects the quality of the seed hence, the performance of the resultant crop (Modupeola *et al*., 2014).Germination and consequent seedling emergence depend on the ability of seeds to use reserves more effectively (Bewley *et al*., 2013). Fluted pumpkin seed is recalcitrant in nature with short viability duration and erratic seedling emergence and establishment which affects the yield per unit area and reduces the return on investment. Sowing mixed seeds of a species may result in a non-uniform stand establishment which may lead to heterogeneity in the plant vigour and size (Nik *et al*., 2011).This study was carried out to evaluate the effects of seed size and seed position in pod on the seed vigour of fluted pumpkin.

METHODOLOGY

The experiment was carried out at the horticultural nursery Federal University of Technology, Minna, Niger State. Five fluted pumpkin pods of equal sizes were obtained from Niger river basin authority, Minna Niger state. The pods were gently opened and the bunch of the seeds were measured and divided into three equal portions viz, interior, middle and posterior section (close to pedicel) of the fruit. The seeds from each position were collected separately and washed under running water. The seeds were air dried for four days in the laboratory and sorted into three sizes: big, medium and small respectively i.e The weight range are ≥ 8.6g as big, 7.6 - 8.5 as medium and ≤ 7.5g as small. Top soil was collected and sterilized; a kilogram of the sterilized soil was filled intoeach polythene bag.

Treatments and Experimental Design

The experiment was a 3 x 3 factorial combination of three seed position in pod (anterior, middle and posterior section) and three seed sizes(big, medium, and small). The treatments were arranged in completely randomized design with five replicates. Each of the polythene bags was planted with one seed each at 7cm depthand watered every day. Data were collected on number of days to emergence, percentage emergence, and emergence rate index. Emergence rate index was calculated as:

$$ERI = \frac{EP1}{N1} + \frac{EP2}{N2} + \cdots \frac{EPn}{Nn}$$

Where ERI= Emergence rate index, EP1, EP2, EPn corresponds to the emergence percentage at first, second, up to the last count respectively and N1, N2, Nn represent the number of days to the first, second up to the last count respectively (Adapted from Hartman *et al*., 2007).

Data Analysis

Data collected were subjected to analysis of variance using Statistical Analysis System (SAS) version 9.2. The means were separated using least significant difference (LSD), where treatment means shows significant differences.

RESULTS AND DISCUSSION

Seeds extracted from the middle position had the highest (29.58%) seedling emergence at 8days after sowing. This was statistically similar to the value recorded (24.71%) for seeds from the anterior position . The least value (5.11%) was recorded for seeds in posterior end of the fruit. Similar trend was observed at 11,13, and 15 days after sowing. The posterior seeds consistently had the least emergence percentage up to 16 days after sowing (DAS) while the anterior seeds consistently had the highest emergence percentage at 12-19 DAS (Figure 1). Ekwealor *et al*., 2019 reported that seeds extracted from the middle of fluted pumpkin pod had higher germination percentage, vine length, stem girth, number of leaves and leaf area, which corroborates the result obtained at 12-19 DAS in this study. Aremu and Akinwale (2012) observed that seeds from the anterior position had the highest vigour performance. However, in their own study, Ekwealor *et al*. (2019) reported the least emergence percentage was recorded in the anterior (near head) position. The disparity in result may be attributed to the genetic make up and growth environment of the seeds, both of which influences germination and seedling growth. In seed formation, pod encapsulate the seeds and protect the seeds. It is the immediate environment of growing seeds. Pods can regulate seed growth and maturity (Bennette *et al*., 2011). Signals originating from the pod may act to coordinate grain filling and regulate the reallocation of reserves from damaged seeds to those that have retained viability.

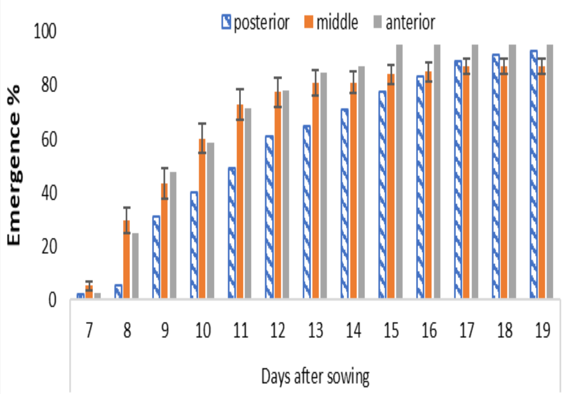

Fig 1. Effect of seed position in pod on the seedling emergence of *Telfria occidentalis*

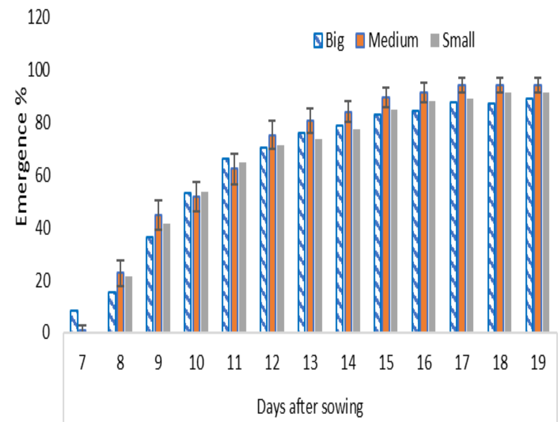

Fig 2. Effect of seed size on the seedling emergence of *Telfria occidentalis*

Big sized seeds were the fastest to emerge having significantly highest emergence percentage at 7 DAS. None of the small seed emerged at 7DAS. Big sized seeds contain more food reserve for the growing embryo than their smaller counterpart. Therefore, it is generally believed that large seeds have higher surviving rate than smaller seeds. Saeed and Sauka (2000), reported that larger seeds of *Senna occidentalis* emerged more rapidly than the smaller seeds. This was attributed to the longer root and shoot observed in the larger seeds. They however reported that smaller seeds germinated faster (had higher germination velocity). In this study, the middle seeds consistently had the highest emergence percentage from 12-19 DAS similarly at 8 and 9 DAS (Figure 2)

Anterior seeds had the highest (input value here) emergence rate index value and it was statistically significant as well as the value recorded in the middle seeds. The least was recorded in the posterior seeds (Figure 3). The medium sized seeds had the significantly highest emergence rate index while the values recorded in the small sized seeds and the big sized seeds were at par (Figure 4). The emergence rate index is an indicator of vigour. It reveals the germination capability and the speed of emergence. Rapid seedling emergence increases the chance of seedling establishment. Sousa and Fagundes (2014) reported that small seeds had higher germination percentage and germinated faster than larger seeds though larger seeds gave more vigorous seedlings. The significantly higher emergence rate index observed in the medium seeds in this study might be attributed to the fact that the medium seeds being midway combined the advantages of faster germination of smaller seeds and longer plumule and radicle length of larger seeds to obtain higher emergence rate index. There was no significance interaction between the position of seed in pod and size of seed in all the parameter measured.

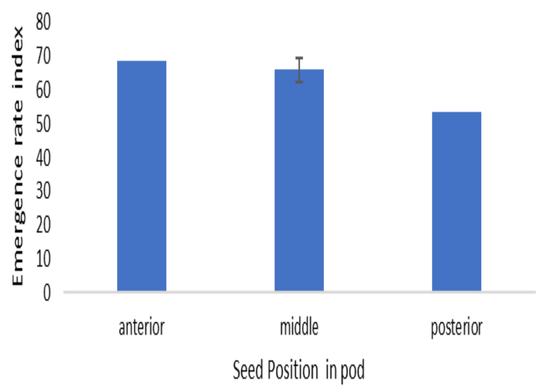

Fig 3. Effect of seed position in pod on the emergence rate index of *Telfria occidentalis*

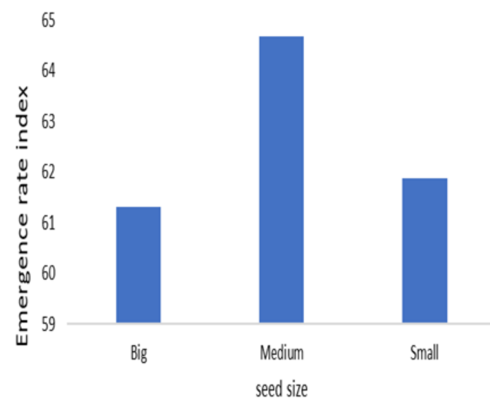

Fig 4. Effect of seed size on the emergence rate index of *Telfria occidentalis*

CONCLUSION

The position of seed within the pod and their sizes had significant effects on the seed vigour of fluted pumpkin. Medium sized seeds extracted from the middle and anterior position of fluted pumpkin pods appear to have more potential to give uniform and better field establishment for optimum productivity of the crop.

REFERENCES

Akanni-John, R., Shaib-Rahim, H. O., Eniola, O. &Elesho, R.O. (2020). Economic Analysis of Fluted Pumpkin (TelfariaOccidentalis) Production in Ibadan Metropolis, Oyo State, Nigeria. *International Journal of Environmental & Agriculture Research*, 6(6), 107 – 121

Aremu C.O & Akinwade D.B. (2012). Origin and Seed positional effect on seed Ratio of *Telfairia occdentalis* Hook of Grown in savanna Agro ecology international *Journal of plant Breeding and Genetics*, 6: 32-39.

Benneth E.J, Jeremy A, Roberts C.W. (2011). The role of the pod in seed development, Strategies for manipulating yield.

Bewley J.D, Kent J.B, Henk W.M.H, and Monogaki H. (2013).Psychology of development, germination of seed, 3rd edition.

Ekwealor K.U (0220). Effect of seed position in the pod on the Germination and Development of Telfairia occidentalis. *Asian plant Research journal*, Pp. 1-6.

Finge -Savage and Bassel (2016). The response of carrot (Decucuscarota) and Onion (Allium cepal).Seedling to mechanical impedance and water stress at sub-optimal temperatures plantcell and Environment 22 (3) 229-242.

Hartman A.l, E;leenP.and Vining P.(2007). Clinical Aspects of the Ketogenic Diet wiley online LibraryEpilepsia/Volume 48, issue 1/page 31-42.

Jerlin, R., &Vadivelu, K. K. (2014). Effect of fertilizer application on nursery for elite seedling production of pungam (*Pongamia pinnate* L.) *Journal of Tropical Agricultural Research Extension,* 7:69-71.

Modupeola T.O, Olaniyi J.O, Abdulrafiu A. M, Akinyode E.T, Taylor O.O; Bidmus F.A and Oyewusi A. D (2014) Effect of Seed Size and Position in the Early Growth of Flutted Pumpkin (*Telferiaoccidentalis*) in Southwest Nigeria. *Research Journal of Seed Science*; Volume 7(1) 26-30.

Nik, M. M., Babaeian, M. &Tavassoli, A. (2011). Effect of seed size and genotype on germination characteristic and seed nutrient content of wheat.Scientific Research and Essays. 6(9): 2019- 2025

Nwosu, C. S., Onyeneke, R. U. &Okoli, V. B. N. (2012). Socio-economic determinants of fluted pumpkin leaf (Telferiaoccidentalis) Production in EzinihitteMbaise Local Government Area of Imo State, Nigeria. *Agricultural Science Research Journal*. 2(6), 355-361.

Saeed Ms and Sauka S.S (2000). Effect of seed size on Germination, Emergence, Growth and seedling Survival of sennaoccidentalis link. *Pakistan Journal of Biological Science* 12(4), 292 -295.

Sousa M.L and Fagundes M. (2014). Seed sizes key factor in Germination and seedling Development of Copaiferalangsdorififi (Fabaceace). *American Journal of plant science*. 7(17), 409-410

95 EFFECTS OF MOISTURE STRESS AT DIFFERENT GROWTH STAGES ON THE PERFORMANCE OF ONION (*Allium cepa* L.) VARIETIES

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Abstract

Climate change is imparting negatively on global crop production and compromising food security worldwide. To breed for moisture stress tolerance in any given crop, it is important to know the precise water needs of the plants and the growth stage at which moisture stress affect the crop most. Hence, this research aimed at determining the response of onion varieties to moisture stress at different stages of growth. The field experiment was carried out at Maizube Farms Limited field, Minna, Niger State (latitude $9^0$3817.1^{0}N; longitude $6^0$32^{i}04.2^{0}E). The treatments consisted of five varieties of onion (red creole, sivan, prema, wuyan makwarwa, wuyan bijimi) and moisture stress at three growth stages of the plant (flag leaf emergence to two true leaves stage (10-50 days post seeding (PS)), three to seven leaves stage (50-90 days PS), bulb initiation to bulb enlargement stage (90-170 days PS) as well as irrigation throughout the growth stages on a daily basis and at 3 days interval. The 5 x 5 factorial experiments were laid out in Completely Randomized Design (CRD) with three replications. Data were collected on growth and yield parameters. The result obtained shows that the varieties responded to moisture stress in similar ways. Drought stress significantly reduced the growth and yield of the onion varieties tested at all the growth stages compared to plants watered throughout the growth stages at 3 days interval which produced the highest number of leaves, plant height and bulb yield. However, the effect of the drought stress was more critical at the early growth stage (flag leaf to two true leaf stage) reducing bulb yield by 57.74%. Similarly, daily irrigation induced flood stress in onion and significantly reduced onion bulb yield by 59.22% .

Key words: Moisture stress; Onion, Growth stages, Climate change, Irrigation

Introduction

Water is the most important factor in agricultural production for proper development and productivity. Every plant needs optimum water supply to meet its physiological requirements (Evans and Sadler, 2011). Water stress is referred to as a limited water supply to plant roots (drought stress) or too much water resulting in flood stress in plant. Water stress results in disruption of agriculture, hence it affects food production in the world, resulting in famine (Chaves *et al*., 2012). Drought stress commonly affect crops; reduces the rate of transpiration in plants thereby affecting metabolism, growth and development of crops. The profound alterations to physiological processes under dehydration slow down or even arrest growth and endanger yield stability (Anjum *et al*., 2011). Yield losses in the field under drought typically range between 30% and 90%; they differ between crop species (Hussain *et al*., 2019). Flood stress similarly impair gaseous exchange thereby causing energy imbalance and reduction of photosynthesis.

Onion (*Allium cepa* L.) is one of the most important vegetable crops commercially grown in the world. It is a popular vegetable, and its bulb is used raw, sliced for seasoning salads, and cooked with other vegetables and meat. Onion bulbs are essential ingredients in many African sauces and dishes. The leaves, whole immature plants called 'salad onion' or leafy sprouts from germinating bulbs are used in the same way. It probably originated from Central Asia between Turkmenistan and Afghanistan where some of its relatives still grow in the wild (Brewster, 1999). It is a shallow rooted crop; its root penetration is around 0.18 m which indicates it cannot take up moisture from deep soils. This makes it sensitive to drought stress. Bulk of the onions planted in Nigeria is produced in the north where irrigation water is a limiting factor. It is mostly planted at the onset of dry season so that it matures into the dry season to avoid flood stress. Previous studies indicated that water deficit negatively affects onion bulb formation which resultantly hinders its quality and yield (Chaudhry *et al*., 2020; Ghodke *et al*. 2020). Water stress at specific stages can negatively impact onion size and quality (Pérez-ortolá and Knox, 2015). To reduce the impact of climate change on food security, it is important to use moisture stress tolerant varieties. To breed for moisture stress tolerance in any given crop, it is important to know the precise water needs of the plants and evaluate the growth stage at which moisture stress affect the crop most. Hence, this research aimed at determining the response of onion varieties to moisture stress at different stages of growth.

MATERIALS AND METHODS

The field experiment was carried out at Maizube Farms Limited field, Minna, Niger State (latitude.9^{0}3817.1^{0}N; longitude 6^{0}32^{i}04.2^{0}E). It is semi- arid with average rainfall of about 750-1209.7 mm per annum. The relative humidity ranges from 21- 47% and 51-79% during the dry and rainy seasons respectively. Temperature averages between 14-30^{o}C during the rainy season and 27-41^{o}C during the dry season (NNN, 2020).

The onion cultivars were obtained from the Institute of Agricultural Research (IAR), Zaria Nigeria. The treatments were five varieties of onion (Red creole, Sivan, Prema, Wuyan makwarwa, Wuyan bijimi) and moisture stress at three growth stages of the plant (flag leaf emergence to two true leaves stage (10-50 days post seeding (PS)), three to seven leaves stage (50-90 days PS), bulb initiation to bulb enlargement stage (90-170 days PS), irrigation at 3 days interval throughout the growth stages) and daily irrigation throughout the growth stages). The 5 x 5 factorial experiments were laid out in Randomized Complete Block Design (RCBD) with three replications. The seeds were planted at a spacing of 20 cm between rows and 15 cm within rows. The net plot size was 2 m x 3 m. Drip irrigation was used in wetting the crop at root level through the use of hose with emitters, the emitters emit water in a trickle form. The diameter of the drip tape was 16 mm and emitters were spaced at 15 cm. The water emission rate was 4 liters per hour per treatment plot. Moisture stress was imposed at the different stages by delaying irrigation till plants show symptoms of temporary wilting. Data were collected on plant height, number leaves, leaf area index, number of days to flowering, bulb diameter and length, bulb yield (kg/ha). The data collected were subjected to Analysis of Variance (ANOVA). Means were separated using least significant difference (LSD) at 5% level of probability.

RESULT

The effect of moisture stress at different growth stages on the plant height of onion varieties is presented in Table 1. Plant to which moisture stress was imposed at 10-50 days had the least plant height (8.57cm) at 4 WAS. The value was statistically similar to plants that were watered every day. Similar trend was observed at 8 and 12 WAS but at 16 WAS, plant stressed at 10-50 days PS appeared to have overcome the initial stress having statistically similar plant height with plants watered at three days interval throughout the growth stages. Plants watered throughout the growth stages at three days interval had the tallest plants throughout the sampling period except at 4 WAS. The varieties responded to moisture stress in similar ways as there was no significant difference ($p>0.05$) among the varieties in respect of plant height throughout the sampling period. The interaction between moisture stress treatments and varieties were not also significant.

Table 1: Effect of moisture stress at different growth stages on the plant height(cm) of onion varieties

Treatments	Weeks after sowing			
	4	8	12	16
Moisture stress (M)				
10 – 50 days	8.57c	14.26b	18.89b	36.46a
50 – 90 days	10.83a	17.23a	21.37a	35.62ab
90 – 140 days	10.13ab	15.55ab	20.97a	36.20ab
Daily watering	9.21bc	15.17b	19.88ab	32.79b
3 days Interval watering	10.27ab	17.39a	21.65a	39.17a
LSD (0.05)	1.14	1.96	1.95	3.67
Varieties (V)				
Red creole	9.65a	15.66a	19.83a	35.75a
Sivan	9.69a	15.93a	20.97a	36.77a
Prema	10.17a	16.63a	21.68a	36.32a
Wuyan makwarwa	9.88a	16.44a	20.09a	36.47a
Wuyan bijimi	9.64a	14.93a	20.19a	34.92a
LSD (0.05)	1.14	1.96	1.95	3.67
Interaction M x V	NS	NS	NS	NS

Means followed by same letter(s) in a column within the same factor are not significantly different at 5% level of probability using least significant difference (LSD). NS- Not significant

The effect of moisture stress at different growth stages on the number of leaves of onion varieties is presented in Table 2. There was no significant difference between the moisture stressed and control plants at 4 WAS. At 8 WAS however, the plants stressed at the different growth stages had similar number of leaves which were significantly lower than the values recorded in the non-stressed plants watered at 3 days interval. Daily watered plants had similar lower number of leaves like the plant stressed at different growth stages. Similar trend was observed at 12 WAS. At 16 WAS however, plant stressed at the bulb formation stage had the least number of leaves. The value obtained was however similar to what was recorded in the daily watered plants. The highest number of leaves was recorded in the non-stressed plants watered at 3 days interval throughout the sampling period. There was no significant difference among the varieties in respect of the number of leaves throughout the sampling period.

Table 2: Effect of moisture stress at different growth stages on the number of leaves of onion varieties

Treatments	Weeks after sowing			
	4	8	12	16
Moisture stress (M)				
10 – 50 days	2.00a	3.13b	4.00b	6.07b
50 – 90 days	2.13a	3.07b	4.07b	5.80bc
90 – 140 days	2.00a	2.93b	4.20ab	5.40c
Daily watering	2.27a	3.13b	4.07b	5.47bc
3 days watering interval	2.46a	3.60a	4.73a	6.80a
LSD (0.05)	0.49	0.41	0.56	0.66
Varieties (V)				
Red creole	2.07a	3.07a	4.07a	6.07a
Sivan	2.33a	3.27a	4.33a	6.20a
Prema	2.13a	3.13a	4.13a	5.60a
Wuyan makwarwa	2.20a	3.27a	4.40a	5.93a
Wuyan bijimi	2.13a	3.13a	4.13a	5.73a
LSD (0.05)	0.49	0.41	0.56	0.67
Interaction (M x V)	NS	NS	NS	NS

Means followed by same letter(s) in a column within the same factor are not significantly different
at 5% level of probability using least significant difference (LSD). NS- Not significant

Table 3 shows the effect of moisture stress at different growth stages on the bulb size and yield of onion varieties. The stressed plants produced significantly shorter bulbs than the non-stressed plant watered at 3 days interval except plants stressed at mid growth stage (three to seven leaf stage) which had statistically similar bulb length with the non-stressed plants. The daily watered plants also had similar short bulb with the drought stressed plants. Bulbs of the daily watered plants were the smallest (with the least bulb diameter). The value obtained was however statistically similar to what was recorded in plant stressed at the early (flag leaf emergence to two true leaves stage) and mid growth stage. Non stressed plants watered at 3 days interval throughout the growth stages had the highest yield (4299.95 kg ha^{-1}). Moisture stress at flag leaf to two true leaf stage reduced onion yield by 57.74% compared to the non-stressed plants. While drought stress at mid growth stage and bulb formation stage reduced bulb yield by 40% and 48.54 % respectively compared to the non-stressed plants. The highest yield reduction (59.22%) was observed in the daily watered plants when compared to the non-stressed plant watered at three days interval throughout the growth stages. The value obtained (1753.35 kg ha^{-1}) were however similar to the bulb weight recorded in plants stressed at the flag to true leaf stage

(1817.35 kg ha^{-1}). There was no significant difference among the varieties in respect of the bulb length and diameter. Sivan variety produced the highest bulb yield (2754.15 kg ha^{-1}) but statistically similar to the value recorded in Red creole, Prema and Wuyan Bijimi. The least yield was obtained in Wuyan makwarma (2018.55 kg ha^{-1}).

Table 3: Effect of moisture stress at different growth stages on the Bulb length, bulb

Treatments	Bulb length (cm)	Bulb diameter (cm)	Bulb yield (kg ha^{-1})
Moisture stress (M)			
10 – 50days	4.49b	4.08bc	1817.35c
50 – 90days	4.83ab	4.09bc	2583.15b
90 – 140days	4.47b	4.36b	2212.75bc
Daily watering	4.52b	3.89c	1753.35c
3 days watering interval	5.07a	5.43a	4299.95a
LSD (0.05)	0.53	0.3	715.6
Variety (V)			
Red creole	4.54ab	4.42a	2664.15ab
Sivan	5.06a	4.27a	2754.15a
Prema	4.55ab	4.45a	2548.55ab
Wuyan makwarwa	4.69ab	4.23a	2018.55b
Wuyan bijimi	4.53b	4.49a	2681.15ab
LSD (0.05)	0.53	0.3	715.6
Interaction (M xV)	NS	NS	NS

Means followed by same letter(s) in a column within the same factor are not significantly different at 5% level of probability using least significant difference (LSD). NS- Not significant

Discussion

Drought stress significantly reduced the growth and yield of the onion varieties compared to the non-stressed plants in this study. This was expected as water is needed for cell division and elongation which is responsible for increase in plant growth. Onion is a shallow-rooted plant that requires frequent irrigation to achieve good yield. Drought induces a complex array of responses in plants including stomatal closure, reduced turgor pressure, altered leaf gas composition and reduced photosynthesis rates leading to reduced growth and crop yield (Farooq *et al*., 2012). Al-Jammal *et al*. (2000) reported that onions under water deficiency decrease in its evapotranspiration and consequently yield. Plants watered daily similarly had reduced growth and bulb yield like the drought stressed plants. This is an indication of overwatering which results to flood stress in plants. Too much soil moisture presents another extreme condition for plants leading to inhibition of gas exchange; oxygen is depleted which restricts respiration and therefore causes energy imbalance and reduction of photosynthesis. Olalla F. *et* *al*. (2004) reported that the lower the volume of water onion received, the higher the efficiency obtained. However, if the volume of water is low enough to induce moisture stress in the plant, growth and yield will be affected.

There was significant reduction in the plants performance when drought stress was introduced at the different growth stages but plant stressed at the early growth stage; flag leaf to two true leaf stage appears to be more affected. Pelter *et al* (2004) similarly reported that moisture stress at 3-7 leaf stage reduced onion bulb yield by 26% compared to the control which were irrigated throughout the growth stages. Contrary to the result obtained in this study however, Dirirsa *et al* (2021) reported that moisture stress at early growth stage did not significantly reduce the bulb yield of onion. The difference may be as a result of the extent of the moisture stress in the two studies as well as the varieties used. Plants stressed at the early growth stage had the least survival rate in this study. This contributed to the reduced yield recorded compared to the moisture stress imposed at other stages. The mid growth stages was not as affected as much as early growth and bulb formation stage in this study. Dirirsa et al (2021) similarly reported that depriving onion water at bulb formation stage resulted in lower bulb yield compared with the other stages. The significantly lowest number of leaves recorded in plant stressed at the bulb formation stage may be attributed to preferential partitioning of assimilates to bulb at this stage which is further aggravated by insufficient moisture. At reproductive stage, plants partition more assimilates to the reproductive structures than other organs. With the occasion of drought stress, the plant will rather partition the little assimilate available to the reproductive structures than the leaves. This explains why the drought stressed plant senesce faster. Sivan variety produced significantly higher yield than Wuyan makwarwa in this study. This may be attributed to the fact that Sivan is a hybrid and Wuyan makwarwa a landrace. Hybrids possess higher yield traits and tolerance/resistant to environmental stress than unimproved varieties. Adediran (2020) reported between 143-318% increase in grain yield and gross margin increase by 300% and above in cowpea when some improved varieties were used compared to landraces.

CONCLUSION

Drought stress significantly reduced the growth and yield of the onion varieties tested at all the growth stages compared to the control. However, drought stress introduced at the early growth stage (flag leaf to two true leaf stage) appeared to be more critical. Furthermore, overwatering significantly affected onion growth and yield more than drought stress hence should also be avoided as much as drought stress in onion production. Watering at 3 days interval throughout the growth stages is therefore recommended for optimum performance of onion in the agro-ecology.

Reference

Adediran O. A. (2020). Physiological responses of cowpea (V*igna unguiculata* L. Walp) varieties to rhizobia inoculation, phosphorus application and sequential cropping system in Minna, Nigeria. A thesis submitted to the Department of Crop Production, Federal University of Technology, Minna.

Al-Jamal, M. S., Sammis, T. W. and Ball S. (2000). Computing the crop water production fuction for onion. *Agricultural water management* 46(1) 29-41.

Anjum, S. A., Xie, X.Y., Wang, L. C., Saleem, M. F., Man, C., & Lei, W. (2011). Morphological, physiological and biochemical responses of plants to drought stress. *African Journal of Agricultural Research*, 6, 2026–2032.

Brewster, J. L. (1999). *Onions and other vegetable alliums* (1st ed.) Wallingford, UK: CAB International. p. 16.

Chaudhry, U. K. & Gökçe, A. z. Junaid, M. D., (2020). Climate Change and Plant Growth–South Asian Perspective. Climate Change and Plants: Biodiversity, Growth and Interactions. Pp.37. https://doi.org/10.1201/9781003109037

Chaves, M. M., Pereira, J. S., Maroco, J., Rodrigues, M. L., Ricardo, C. P. P., Osorio, M. L.,

Carvalho, I., Faria, T., & Pinheiro, C. (2012). How plants cope with water stress in the field? Photosynthesis and growth. *Ann Bot* 89(7), 906–917.

Dirirsa, G. T. Hordofa, Ketema Tezera, Abera Tesfaye, Tatek Wendimu (2021). Response of Onion (Allium Cepa L.) to Soil Moisture Stress Conditions at Different Growth Stages under Semi-arid Area of Ethiopia. *Irrigation and Drainage System Engineering*, 10(2), 2-4.

Evans, R. G., & E. J. Sadler. (2011).. Methods and technologies to improve efficiency of water use. *Water Resource Research* 44: 04

Farooq M. Hussain M. Wahid A. Siddique KNM (2012). Drought stress in plants: An overview. In Aroca R. Ed, Plant responses to drought stress. Springer, New York, Pp 1-33

Growth stages on onion bulb yield and quality. *Agricultural water management* 68(2), 107-115

Grubben, J. H. & Denton, D.A. (2004). Plant Resources of Tropical Africa. PROTA Foundation, Wageningen; Backhuys, Leiden, CTA, Netherlands.

Hussain, S., Hussain, S., Qadir, T., Khaliq, A., Shraf, U., Parveen, A., Saqib, M., & Rafiq, M. (2019). Drought stress in plants: an overview on implications, tolerance mechanisms and agronomic mitigation strategies. *Plant Science Today*, 6, 389–402.

Martin de santa Olalla F. & Lopez R. (2004). Production and quality of the onion crop (Allium Cepa L.) cultivated under controlled deficit irrigation conditions in a semi- arid climate. *Agricultural water management*. 68(1), 77-89.

Pelter G. O., Mittelstadt R., Leib B. G. Redulla C. A. (2004). Effects of water stress at specific growth stages on onion bulb yield and quality Agricultural water management 68(2), 107-115

Pérez-ortolá M. and Knox J.W. (2015). Water relations and irrigation requirement onion (Allium Cepa L.): a review of yield and quality impacts. *Experimental Agriculture* 51(2) 210-231

96 WEEDING FREQUENCY EFFECT ON GROWTH AND YIELD OF MAIZE IN SOUTHERN-GUINEA SAVANNAH

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Abstract

A field trial was conducted in 2018 cropping season on the Teaching and Research Farm of the Federal University of Technology, Gidan Kwano campus to investigate the effect of weeds on the growth and yield of maize and determine the best time and frequency of weeding for optimum yield. The Treatments (no weeding (control), weeding at 2WAS, weeding at 4WAS, weeding at 6WAS, weeding at 8WAS, weeding at 10WAS, weeding at 2 and 4WAS, weeding at 4 and 6WAS, weeding at 6 and 8WAS, weeding at 8 and 10WAS) were layout in a randomized complete block design (RCBD), replicated three (3) times. The data collected on various parameters were subjected to analysis of variance (ANOVA) using statistical package (SAS 2016) and means were partitioned using Duncan multiple range test (DMRT) at 5% level of probability. The results obtained showed that the use of hybrid maize variety with early weeding at 4 and 6WAS which resulted in lower weed cover score, lower weed dry weight, lower number of days to 50% tasseling, maize taller plant, high maize cob weight and high yield could be an effective weed management strategy.

Keywords: Maize, Weeding frequency, Growth; Yield

INTRODUCTION

Maize (*Zea mays* L.) has long been seen to be one of the world's most promising cereal grains for human consumption (Tandzi and Mutengwa 2020). Among the factors constraining the production of maize in the tropics are inadequate supply of nutrients in the soil most especially nitrogen and intense competition with weeds. At the early stage of crop growth and development, the weed and rice plant requirements for nutrients are met but as growth advances for the two plant species, the nutrient supply normally falls short of the combining demands leading to competition(Musa and Timbale 2013). Maize is highly susceptible to weed competition particularly at the early stage of growth. In Nigeria, yield losses as high as 51 to 100% have been recorded in maize due to weed competition (Akobundu and Ekeleme 2000). According to Rao and Kang(Rao and Kang 2010), high cost of inputs such as fertilizer, improved seeds were of no use if not accompanied with efficient weed control. Maize (*Zea mays L*) is a member of the family Graminae and it is an annual crop serving as a good source of food for human consumption in form of maize powder, maize meal and confectionaries such as bread, biscuits and cakes. Maize is world’s one of the three most popular cereal crops.It is grown worldwide on approximately

130 million ha annually with a production of 574 million metric tons (Itos 1998). For the past five decades, since Nieto *et al*. (1968) introduced the concept of 'critical periods of the crop growth cycle for competition from weeds', it has been accepted by the international community that there are certain periods in the life cycle of a crop when weeds pose challenges to the resource competition and must be removed to accelerate crop growth; it is believed that thereafter the presence of weed species could insignificantly interfere with crop yield. In particular, the concept considers the period from sowing to a specific stage/phase of the crop to advocate cultural, mechanical or chemical weed management practices.Critical period of weed control (CPWC) consider the yield loss due to the presence of all weeds present in the crop cycle. The CPWC is the time interval between the critical timing of weed removal (CTWR) and the critical weed-free period (CWFP), and the weed presence before and after the extremes of CTWR and CWFP may not significantly reduce crop yield. Although CPWC has been defined in different ways, it is generally accepted that CPWC is a time interval between two components viz., the critical timing of weed removal (CTWR) and the critical weed-free period (CWFP), and the weed presence before and after CPWC should not significantly reduce crop yield. In general, three relationships exist in CPWC (Nadeem *et al*., 2013): (a) Maintaining the crop weed-free for the same duration that a weed infestation can be tolerated to avoid yield loss if weed control is performed during this period; (b) CWFP is lesser than CTWR so that yield loss will not occur if weeds are managed between these extremes; and (c) CWFP is of no longer duration than the CTWR, the crop must be kept weed-free between these timings to prevent yield loss. Knezevic *et al*. (2002) considered CPWC as a window for the removal of weedy species. IITA (2007) also reported that weedness of maize field may increase the incidence of insect pest infestation which can cause yield loss to about 60-85%.

MATERIALS AND METHODS

A field trial was conducted in 2019 cropping season at the Teaching and Research Farm of the Federal University of Technology, Gidan Kwano Campus Minna, Niger State, located in the Southern Guinea Savannah Agro-ecological Zone of Nigeria. The Treatments (no weeding (control), weeding at 2WAS, weeding at 4WAS, weeding at 6WAS, weeding at 8WAS, weeding at 10WAS, weeding at 2 and 4WAS, weeding at 4 and 6WAS, weeding at 6 and 8WAS, weeding at 8 and 10WAS) were layout in a randomized complete block design (RCBD). Two seeds were sown per hole at 25cm by 75cm intra and inter-row spacing respectively and later thinned to one per stand after two weeks. Weeding was done according to the experimental treatment. N.P.K 15:15:15 was applied at the rate of 180kg N, 90kg P_205 and 90kg K_2O ha^{-1} plant stand at 3WAS. Data were collected on weed cover score, weed dry matter, maize plant height, number of days to 50% tasseling, dry cob weight and grain yield. Weed cover score was taken from each plot on visual rating 1 to 6, where, 1- Clean plot, 2- Moderately Clean plot, 3- Fairly Clean plot, 4- Moderately weedy plot and 5- Fairly weedy. Samples of fresh weed were taken from a 50cm quadrant thrown in each net plot prior to each weeding operation at 6, 8 and 10 WAS. The weed samples were weighed to obtain the fresh weight, oven dried at 70^0c to a constant weight and weighed to obtain dry matter content (grams per m^{-3}).Plant height of the randomly tagged selected maize plants were measured using measuring tape from the ground levels to the apex of the flag leaf at 4, 6, and 8 WAS. The number of days to 50% tasseling was taken by visual observation and recorded, the maize cobs weight were randomly sampled per each plot and weight using weight balance in gram (g). Maize grain yield from each plot after shelling and winnowing were weighed with a meter balance and expressed in gram(g).The data collected were subjected to analysis of variance (ANOVA) using statistical package (SAS 2016) and means was partitioned using Duncan multiple range test (DMRT) at 5% level of probability.

RESULTS

Effect of time of weeding and weeding frequency on weed cover score and weed dry weight

Weeding at 4 and 6WAS significantly ($P<0.05$) recorded lower weed cover score compared to other treatments and control (Table 1). Weeding at 2WAS, 6WAS and 4 and 6W was significant, implying that they succeeded in reducing weed plants as compared to other treatments (Table 1).

Effect of time of weeding and weeding frequency on maize plant height and number of days to 50% tasseling

Plant heights were significantly difference ($p < 0.05$) throughout the sampling period, weeding at 2 and 6WAS produced taller plant height compared to other treatments (Table 2). Lower number of days to 50% tasselling was seen on weeding at 2 and 4WAS compared to other treatments

Effect of time of weeding and weeding frequency on maize cob weight and grain yield

The effect of time of weeding and weeding frequency on cob weight were differed significantly ($p < 0.05$) in which treatment with weeding at 4 and 6WAS recorded higher cob weight compared to other treatments (Table 3). Grain yield were significantly difference ($p < 0.05$) with weeding at 4 and 6WAS recorded higher grain yield compared to other treatments

Table 1: Effects of time of weeding and weeding frequency on weed cover score and weed dry weight.

Treatment	Weed Cover Score			Weed Dry Weight		
	4WAS	6WAS	8WAS	6WAS	8WAS	10WAS
No Weeding (Control).	5.00a	5.67a	6.00a	35.38a	59.20a	63.62a
Weeding at 2 WAS	3.00d	3.33d	3.67c	12.14c	22.41c	40.61b
Weeding at 4 WAS	3.33c	2.67d	3.67c	10.78d	17.67d	37.18b
Weeding at 6 WAS	4.33b	4.67b	2.33d	30.03b	14.26d	12.90d
Weeding at 8 WAS	4.33b	4.67b	4.33c	33.21a	39.26bc	12.74d
Weeding at 10 WAS	4.67ab	5.33ab	5.00b	34.81a	57.97a	57.77ab
Weeding at 2 And 4 WAS	4.33b	2.67d	2.00d	13.72c	14.75d	17.79c
Weeding at 4 And 6 WAS	4.67ab	2.67d	2.00d	12.90c	13.83d	15.15c
Weeding at 6 And 8 WAS	4.33b	4.38b	4.00c	30.69b	14.81d	12.35d
Weeding at 8 And 10 WAS	4.67ab	5.67a	5.76ab	31.44b	46.19b	57.12a
SE ±	0.22	0.33	0.39	21.61	5.45	4.67

Means followed by the same letter(s) on a column are not significantly different according to Duncan Multiple Range Test (DMRT) at p=0.05. WAS: Week after Sowing

Table 2: Effect of time weeding and weeding frequency on maize plant height and number of days to 50% tasselling

Treatment	Plant Height (cm)			Days to 50% tasselling
	6WAS	8WAS	10WAS	
No Weeding (Control).	60.40^{d}	115.00^{d}	158.33^{d}	63.33^{a}
Weeding at 2 WAS	80.87^{a}	133.67^{c}	166.33^{cd}	57.67^{bc}
Weeding at 4 WAS	75.93^{b}	131.33^{c}	183.33^{bc}	59.33^{abc}
Weeding at 6 WAS	66.33^{c}	117.33^{b}	193.33^{b}	59.33^{abc}
Weeding at 8 WAS	63.40^{c}	130.00^{c}	180.67^{bc}	60.00^{abc}
Weeding at 10 WAS	64.43^{c}	117.00^{d}	171.33^{c}	60.67^{ab}
Weeding at 2 And 4 WAS	81.87^{a}	179.00^{a}	201.67^{a}	54.67^{c}
Weeding at 4 And 6 WAS	70.03^{bc}	153.00^{b}	198.00^{a}	57.67^{bc}
Weeding at 6 And 8 WAS	68.27^{bc}	137.67^{bc}	175.67^{bc}	62.00^{ab}
Weeding at 8 And 10 WAS	62.33^{cd}	117.00^{d}	166.00^{cd}	62.33^{ab}
SE ±	1.83	4.06	4.15	0.63

Means followed by the same letter(s) on a column are not significantly different according to Duncan Multiple Range Test (DMRT) at p=0.05. WAS: Week After Sowing.

Table 3: Effect of time of weeding and weeding frequency on cob weight and grain yield

Treatment	Cob weight (g/plot)	Grain Yield (g)
No Weeding (Control).	2833.3^{b}	2133.3^{cd}
Weeding at 2 WAS	3633.3^{ab}	2066.7^{cd}
Weeding at 4 WAS	3000.0^{b}	2166.7^{cd}
Weeding at 6 WAS	3466.7^{ab}	2733.3^{bc}
Weeding at 8 WAS	3433.3^{ab}	1933.3^{cd}
Weeding at 10 WAS	2700.0^{b}	1833.3^{d}
Weeding at 2 And 4 WAS	4400.0^{a}	3500.0^{ab}
Weeding at 4 And 6 WAS	3733.3^{ab}	3633.3^{a}
Weeding at 6 And 8 WAS	3400.0^{ab}	2700.0^{bcd}
Weeding at 8 And 10 WAS	2966.7^{b}	2233.3^{cd}
SE ±	133.97	131.99

Means followed by the same letter(s) on a column are not significantly different according to Duncan Multiple Range Test (DMRT) at p=0.05.WAS: Week after Sowing.

DISCUSSION

Lower weed cover score and lower dry weight in weeding at 4 and 6WAS could be as a result of the ability of the treatments to reduce weed presence which did not allowed weeds to grow to maturity thus, could not be woody at that time and produced the lower dry weight compared to other treatments. This is in agreement with the work of Rao, (2000) who reported that weed controlled within two or three weeks of emergence reduces weed covers score and weed dry weight. Taller plant heights recorded could be as a result of lower weed presence and early weeding intervention at 4 and 6WAS, better weed management ecreased competition for resources thus, provided optimum supply of resources for growth and development of maize which has translated into taller height. This is in agreement with the finding of Ofunsun-Anim and Limani (2007) reported that provided weeds were subsequently removed, infestation for the first 3WAS did not have adverse effects on the growth and yield of crops. Number of days to 50% tasseling could be as a result of early weeding which helps the plant to have good head start over the weeds. This is in agreement with the findings of Adeosum (2005), Ado (2007) and Osipitan (2010) who all reported that critical period of weed competition occurs during the first 40 days of most crop growth. Higher Cob weight and grain yield could be as a result of lower weed cover and taller plant height which has translated into better yield. This is in agreement with the finding of Shinggu *et al.*, (2009) who reported that effective weed control measures in maize during the first 4-5 weeks after sowing are essential for maximizing the yields in maize.

CONCLUSION

On the basis of this study it is suggested that the use of hybrid maize variety with early weeding at 4 and 6WAS which resulted in lower weed cover score, weed dry weight, taller plant, therefore, it is advisable for the farmers or the growers of maize to do their first weeding 4-6weeks after planting in order to get optimum yield.

REFERENCE

Adeosun, J.O. (2005). Influence of nitrogen and periods of weed interference on yield and yield components of upland rice (Oryza sativa L.) at Samaru, Nigeria. *Nigerian Journal of Weed Science*. 18:45-55

Akobundu, I.O. and Ekeleme, F. (2000). Effect of method of *Imperata cylindrica* management on maize grain yield in the derived savanna of south western Nigeria. Journal of Weed Science,13:22-28.

IITA. (2007). Multiple cropping: www.iitaor-lcms/details/tm-mat

Ito, S. (1998). General Overview on Exploding Maize Demand in Asia International Maize. Knezevic, S.Z.; Evans, S.P.; Blankenship, E.E.; Van Acker, R.C.; Lindquist, J.L. Critical period for weed control: The concept and data analysis. Weed Sci. 2002, 50, 773–786.

Musa, B. J. and Timbale, F. T. (2013). Crop – weed competition in maize. International Maize Research Newsletters.2013; 8(2): 24.

Nadeem A, Tanveer A, Naqqash T, Jhala AJ and Mubeen K (2013) Determining critical weed competition periods for black seed. *The Journal of Animal & Plant Sciences* 23, 216–221.

Nieto, A. J., Borondo, M. A. and Gonzalez, T.J. (1968) Critical periods of the crop growth cycle for competition from weeds PANS 14: 159 -166.

Ofosun-Anin, J., Limbani, N.V. (2007). Effects of intercropping on the growth of cucumber and okra as affected by intercropping. *International Journal of Agricultural and Biological Sciences* 9(4) 594-597

Osipitan, O. A. (2010). Crop weeds interaction as influenced by inter-row spacing, weed interference and control methods in cowpea (Vigna unguiculata (L) Walp). *Journal of Agronomy* 6 (2) 28-37.

Rao, V. S. (2000). Principles of Weed Science. Second edition, Oxford and IBH publishing Co. PVT Ltd. New Delhi India. 204-211

Rao, F..B and Kang, C. S. (2010). Weed and weed management in maize. Advance. Agronomy 22.2010; 108-116

Shinggu, L.P. , Dandari, S.A., Shebayan, J.A.Y., Adekpe, D.I., and Ishaya, D.B. (2009). Effects of variety, crop Arrangement and period of weed interference of maize grown in mixture in Northern Guinea savannah of Nigeria. *International Journal of Agricultural and Biological Sciences*, 8(2) 94-97

Tandzi LN, Mutengwa CS. Estimation of maize (*Zea mays* L.) yield per harvest area: Appropriate methods. *Agronomy Journal*. 2020; 10(1):29.

97 EFFECT OF FOLIAR FERTILIZER APPLICATION ON PHYSIOLOGICAL CHARACTERISTICS AND HERBAGE YIELD OF AMARANTHUS AND CORCHORUS

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Abstract

One-third of children deaths in Africa are attributable largely to protein energy malnutrition and micronutrient deficiencies which can be solved by exploring underutilized nutritious crop. Experiment was conducted at the Crop Production Screen House and Albishiri Irrigation Farm both in Minna during the dry Season of 2021. The objective was to determine he effect of application of organic foliar fertilizers rates on physiology and yield response of leafy vegetables in Minna. The experiment consisted of factorial combination of (10 treatments) in completely randomized design and five rates of foliar fertilizer 0 L ha^{-1}, 0.5 L ha^{-1}, 1.0 L ha^{-1}, 1.5 L ha^{-1} and 2.0 L ha^{-1} and total of 40 pots. Data were collected on plant height, number of leaves, fresh shoot weight and dry weight, leaf area The results indicated that, the effects of organic foliar fertilizer rates on plant height at 4,5 and 6 WAS rate of 2.0 L ha^{-1} produced significantly taller plant the lowest plant height, Number of Leaves respectively it is therefore recommended that farmer should adopt the application of organic foliar fertilizer(Super Agro) at the rate of 2.0 L ha^{-1}.

Keywords: Foliar Fertilizer, Amaranthus, Corchorus, Irrigation, Herbage yield

Introduction

Vegetables refers to the fresh, edible part of a plant that can be consumed raw or cooked (Ward, 2016). This can be classified into fruit vegetables such as tomatoes, cucumber, okra; root and tuber vegetables such as potato, sweet potato, radish; green leafy vegetables such as amaranthus, celery, cabbage and bulb vegetables such as onion, garlic and shallot (Abewoy, 2018). Vegetables are important for nutrition in terms of bioactive nutrient molecules like dietary fiber, vitamins, and minerals (Keatinge *et al.*, 2011). They are resources for overcoming micronutrient deficiencies and provide smallholder farmers with much higher income and more jobs (Abewoy, 2018). Vegetable are produced all over the world but in a varied extent. Asia is the largest vegetable producer. China and India is the two largest vegetable producer of Asia covering 62 % of world's total production with an individual country contribution of 554 and 127 million metric tons respectively (Shahbandeh, 2020). However, on the way of achieving higher yield, they face various challenges such as climate change impacts (Kabir, 2015). Therefore the objectives are to determine the effect of foliar application of organic fertilizer rates on physiology and yield responses of leafy vegetables, to investigate the factors that influence utilization and production of the leafy and nutritional quality of leafy vegetable under the application of different rates of foliar fertilizer.

Materials and Methods

Experimental Site

The experiment was conducted in the dry season of 2021 at the Crop Production Screen House Federal University of Technology and Albishiri Irrigation Farm both Minna (9^{O} 37'N, 6^{O} 28'E). In the Southern Guinea Savanna of Nigeria.

Soil Collection and Sampling of the field experiment

Soil samples were ollected at random across the experimental site at the depth of 0 – 15cm along a transect and then bulked together to form the composite sample.

Experimental materials

Landraces of Amaranthus and corchorus varieties were obtained from the irrigation farmers in Minna Niger State and it was used for the experiment.

Source of foliar fertilizer and its active ingredient

Foliar fertilizer was obtained from an Agro-chemical shop in Minna. The Super gro fertilizer contained Nitrogen 72 g, Phosphorus 45 g, Potassium 30 g, Sulphur 15 g, Calcium 9 g, Magnesium 7 g, Iron 5 mg, Iodine 3 mg, and Zinc 1 mg per litre.

Treatments and experimental design

The screen house experiment were factorial combination laid out in a completely randomized design (CRD) vegetables varieties (Amaranthus and Corchorus) and five rate of foliar fertilizer (Super Gro) (0 L ha^{-1}, 0.5 L ha^{-1}, 1.0 L ha^{-1}, 1.5 L ha^{-1} and 2.0 L ha^{-1}). A total of 40 (pots) treatments. The field experiment was a factorial combination laid out in a Randomized Complete Block Design (RCBD) with three replications.

Land preparation and check basin construction

The land was dug, ploughed and leveled. Then check basins of 3 m x 3 m were constructed the gloss plot size was 3m x 3m (9 m^2) and a net plot of 1.5 m x 3 m (4.5 m^2). An alley of 0.5 m was left between treatments and replicates.

Watering of pots and irrigation of plots

The pots were watered (3liter) before planting and watering was done every other day until harvest.

Data collection

Growth parameters

Five plants in each treatment plot were randomly selected and tagged for the measurements of growth parameter (Plant height, number of; leaves, stem girth, number of branches, leaf area) at 2, 3, 4 and 5 WAS. The length and breadth of the leaves were multiplied by a constant 6 and the mean was then calculated.

Fresh shoot weight (kg ha^{-1})

The fresh whole plants in pot were uprooted and the root washed of soil then weighed using a scale weighing balance, and then extrapolated to per hectare in the screen house.

Dry shoot weight (kg ha^{-1})

The fresh whole plants in pot were uprooted and the root washed of soil, oven dried (140°F) to a constant weight and then weighed using an electronic weighing balance in the laboratory.

Root length (cm)

The root length of five randomly selected plants were measured using meter rules and mean recorded for both screen house and field experiments.

Fresh Root weight

The root of five randomly selected plants were weighed using an electronic weighing balance in the laboratory and recorded for both screen house and field experiments.

Dry Root Weight

The root of five randomly selected plants were oven dried to a constant weight then weighed using an electronic weighing balance in the laboratory and recorded for both screen house and field experiments.

Harvesting

The vegetables were harvested by uprooting the whole plant at maturity (6 WAS).

Data analysis

Data collected were subjected to Analysis of Variance (ANOVA) using the Statistical Analysis System (SAS) package version 9.0 means were separated using Duncan Multiple Range Test (DMRT) at $P \geq 0.05$.

Table 1 Effect of foliar application of foliar fertilizer rates on plant height of Corcurus and Amranthus at 4, 5 and 6 WAS

	Plant height (cm) Weeks after sowing		
Treatment	4	5	6
Fertilizer (F) (L ha^{-1})			
0	28.85c	39.23c	46.95c
0.5	40.81b	60.18a	66.60b
1.0	50.85a	59.60a	67.60b
1.5	41.39b	52.43b	72.37a
2.0	51.83a	63.97a	73.60a
SE±	1.82	2.24	1.24
Vegetables (V)			
Amaranthus	58.62a	77.06a	89.92a
Corchorus	26.87b	33.11b	40.92b
SE±	1.15	1.42	0.78
Interaction			
F × V	**	**	**

Means with the same letter(s) under the same column are not significantly different from each other at P≤ 0.05 by DMRT.

Table 2: Effect of foliar application of organo mineral fertilizer rates on plant height of some vegetables at 4, 5 and 6 WAS grown under irrigation

	Plant height (cm)		
Treatment	4WAS	5WAS	6WAS
Fertilizer (F) (L ha^{-1})			
0	11.02c	17.64c	31.47c
0.5	16.18b	29.08b	41.48b
1.0	24.33a	36.37ab	52.75a
1.5	22.85a	31.48b	52.93a
2.0	23.60a	39.56a	57.25a
SE±	1.48	2.57	2.87
Vegetables (V)			
Amaranthus	26.72a	43.26a	65.84a
Corchorus	12.47b	18.39b	28.51b
SE±	0.93	1.62	1.81
Interaction			
F × V	**	*	NS

Means with the same letter(s) under the same column are not significantly different at P≤ 0.05 by DMRT.

Discussion

The tallest plants obtained with the application of foliar fertilizer (Super gro) at the rate of 2.0 L ha^{-1} could be attributed to the availability of sufficiently high content of macro and micro nutrients in the foliar fertilizer which in turn provided the plants with required nutrient that may be insufficiently supplied through the root system in the soil. This finding is in conformity with the results of Shafeek *at al*. (2013) who reported that the superiority of highest levels of Stimufol foliar nutritional compound fertilizer at the highest levels of 200 g enhancing plant growth may be attributed to its high contents of macro and micro nutrients which provides the plants with required nutrients which one or more of them were insufficiently supplied through the root system in such low fertile soil. The authors also stated that foliar feeding is often the most effective and economical way to correct plant nutrient deficiencies. Abou-El-Nour (2002) reported that foliar application of nutrients could improve the nutrient utilization and lower environmental pollution through reducing the amounts of fertilizer added to soil.

Conclusion

From the results obtained it is concluded that the application of organo mineral fertilizer at the rate of 2.0 L ha^{-1} should be adopted in this agro ecological Zone.

Recommendation

It is recommended that farmers in this agro-ecological zone of Nigeria should adopt the application of (Super gro) at the rate of 2.0 L ha^{-1} for higher growth, yield and nutritional qualities of Amaranthus and Corchorus.

References

Abewoy D (2018). Review on Impacts of Climate Change on Vegetable Production and its Management Practices. Adv. Crop Sci. Tech 6:330. Doi:10.4172/2329-8863.1000330

Abou-El-Nour, E. A. A. (2002). Can supplemented potassium foliar feeding reduce the recommended soil potassium? *Pakistan Journal of Biological Science*, 5(3), 259 – 262.

Kabir MH (2015). Factors influencing adoption of integrated pest management (IPM) strategies by the vegetable farmers of Narsingdi district, Bangladesh. PhD thesis (published), University Science Malaysia, Penang 11800, Malaysia.

Keatinge JDH, Yang RY, Hughes d'A, Easdown WJ, Holme R (2011). The importance of vegetables in ensuring both food and nutritional security in attainment of the Millennium Development Goals. Food Sec. 3:491-501

Shahbandeh M (2020). Leading global producers of fresh vegetables 2017. Retrieved from https://www.statista.com/statistics/264662/topproducers-of-fresh-vegetables-worldwide

Ward AW (2016). *Encyclopedia Britannica.*

Shafeek, M. R., Helmy, Y. I., Nadia, M. O & Rizk, F. A. (2013). Effect of foliar fertilizer with nutritional compound and humic acid on growth and yield of broad bean plants under sandy soil conditions. *Journal of Applied Sciences Research*, 9(6), 3674 – 3680.

98 EFFECT OF FOLIAR FERTILIZER APPLICATION ON PHYSIOLOGICAL CHARACTERISTICS AND HERBAGE YIELD OF AMARANTHUS AND CORCHORUS

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Crop Production

Abstract

One-third of children deaths in Africa are attributable largely to protein energy malnutrition and micronutrient deficiencies which can be solved by exploring underutilized nutritious crop. Experiment was conducted at the Crop Production Screen House and Albishiri Irrigation Farm both in Minna during the dry Season of 2021. The objective was to determine the effect of application of organic foliar fertilizers rates on physiology and yield response of leafy vegetables in Minna. The experiment consisted of factorial combination of (10 treatments) in completely randomized design and five rates of foliar fertilizer 0 L ha^{-1}, 0.5 L ha^{-1}, 1.0 L ha^{-1}, 1.5 L ha^{-1} and 2.0 L ha^{-1} and total of 40 pots. Data were collected on plant height, number of leaves, fresh shoot weight and dry weight, leaf area The results indicated that, the effects of organic foliar fertilizer rates on plant height at 4,5 and 6 WAS rate of 2.0 L ha^{-1} produced significantly taller plant the lowest plant height, Number of Leaves respectively it is therefore recommended that farmer should adopt the application of organic foliar fertilizer(Super Agro) at the rate of 2.0 L ha^{-1}.

Keywords: Foliar Fertilizer, Amaranthus, Corchorus, Irrigation, Herbage yield

Introduction

Vegetables refers to the fresh, edible part of a plant that can be consumed raw or cooked (Ward, 2016). This can be classified into fruit vegetables such as tomatoes, cucumber, okra; root and tuber and vegetables such as potato, sweet potato, radish; green leafy vegetables such as amaranthus, celery, cabbage and bulb vegetables such as onion, garlic and shallot (Abewoy, 2018). Vegetables are important for nutrition in terms of bioactive nutrient molecules like dietary fiber, vitamins, and minerals (Keatinge *et al.*, 2011). They are resources for overcoming micronutrient deficiencies and provide smallholder farmers with much higher income and more jobs (Abewoy, 2018). Vegetable are produced all over the world but in a varied extent. Asia is the largest vegetable producer. China and India is the two largest vegetable producer of Asia covering 62 % of world's total production with an individual country contribution of 554 and 127 million metric tons respectively (Shahbandeh, 2020). However, on the way of achieving higher yield, they face various challenges such as climate change impacts (Kabir, 2015). Therefore the objectives are to determine the effect of foliar application of organic fertilizer rates on physiology and yield responses of leafy vegetables, to investigate the factors that influence utilization and production of the leafy and nutritional quality of leafy vegetable under the application of different rates of foliar fertilizer.

Materials and Methods

Experimental Site

The experiment was conducted in the dry season of 2021 at the Crop Production Screen House Federal University of Technology and Albishiri Irrigation Farm both Minna (9^{O} 37'N, 6^{O} 28'E). In the Southern Guinea Savanna of Nigeria.

Soil Collection and Sampling of the field experiment

Soil samples were ollected at random across the experimental site at the depth of 0 – 15cm along a transect and then bulked together to form the composite sample.

Experimental materials

Landraces of Amaranthus and corchorus varieties were obtained from the irrigation farmers in Minna Niger State and it was used for the experiment.

Source of foliar fertilizer and its active ingredient

Foliar fertilizer was obtained from an Agro-chemical shop in Minna. The Super gro fertilizer contained Nitrogen 72 g, Phosphorus 45 g, Potassium 30 g, Sulphur 15 g, Calcium 9 g, Magnesium 7 g, Iron 5 mg, Iodine 3 mg, and Zinc 1 mg per litre.

Treatments and experimental design

The screen house experiment were factorial combination laid out in a completely randomized design (CRD) vegetables varieties (Amaranthus and Corchorus) and five rate of foliar fertilizer (Super Gro) (0 L ha^{-1}, 0.5 L ha^{-1}, 1.0 L ha^{-1}, 1.5 L ha^{-1} and 2.0 L ha^{-1}). A total of 40 (pots) treatments. The field experiment was a factorial combination laid out in a Randomized Complete Block Design (RCBD) with three replications.

Land preparation and check basin construction

The land was dug, ploughed and leveled. Then check basins of 3 m x 3 m were constructed the gloss plot size was 3m x 3m (9 m^2) and a net plot of 1.5 m x 3 m (4.5 m^2). An alley of 0.5 m was left between treatments and replicates.

Watering of pots and irrigation of plots

The pots were watered (3liter) before planting and watering was done every other day until harvest.

Data collection

Growth parameters

Five plants in each treatment plot were randomly selected and tagged for the measurements of growth parameter (Plant height, number of; leaves, stem girth, number of branches, leaf area) at 2, 3, 4 and 5 WAS. The length and breadth of the leaves were multiplied by a constant 6 and the mean was then calculated.

Fresh shoot weight (kg ha^{-1})

The fresh whole plants in pot were uprooted and the root washed of soil then weighed using a scale weighing balance, and then extrapolated to per hectare in the screen house.

Dry shoot weight (kg ha^{-1})

The fresh whole plants in pot were uprooted and the root washed of soil, oven dried (140°F) to a constant weight and then weighed using an electronic weighing balance in the laboratory.

Root length (cm)

The root length of five randomly selected plants were measured using meter rules and mean recorded for both screen house and field experiments.

Fresh Root weight

The root of five randomly selected plants were weighed using an electronic weighing balance in the laboratory and recorded for both screen house and field experiments.

Dry Root Weight

The root of five randomly selected plants were oven dried to a constant weight then weighed using an electronic weighing balance in the laboratory and recorded for both screen house and field experiments.

Harvesting

The vegetables were harvested by uprooting the whole plant at maturity (6 WAS).

Data analysis

Data collected were subjected to Analysis of Variance (ANOVA) using the Statistical Analysis System (SAS) package version 9.0 means were separated using Duncan Multiple Range Test (DMRT) at $P \geq 0.05$.

Table 1 Effect of foliar application of foliar fertilizer rates on plant height of Corcurus and Amranthus at 4, 5 and 6 WAS

	Plant height (cm)		
	Weeks after sowing		
Treatment	4	5	6
Fertilizer (F) (L ha^{-1})			
0	28.85c	39.23c	46.95c
0.5	40.81b	60.18a	66.60b
1.0	50.85a	59.60a	67.60b
1.5	41.39b	52.43b	72.37a
2.0	51.83a	63.97a	73.60a
SE±	1.82	2.24	1.24
Vegetables (V)			
Amaranthus	58.62a	77.06a	89.92a
Corchorus	26.87b	33.11b	40.92b
SE±	1.15	1.42	0.78
Interaction			
F × V	**	**	**

Means with the same letter(s) under the same column are not significantly different from each other at P≤ 0.05 by DMRT.

Table 2: Effect of foliar application of organo mineral fertilizer rates on plant height of some vegetables at 4, 5 and 6 WAS grown under irrigation

	Plant height (cm)		
Treatment	4WAS	5WAS	6WAS
Fertilizer (F) (L ha^{-1})			
0	11.02c	17.64c	31.47c
0.5	16.18b	29.08b	41.48b
1.0	24.33a	36.37ab	52.75a
1.5	22.85a	31.48b	52.93a
2.0	23.60a	39.56a	57.25a
SE±	1.48	2.57	2.87
Vegetables (V)			
Amaranthus	26.72a	43.26a	65.84a
Corchorus	12.47b	18.39b	28.51b
SE±	0.93	1.62	1.81
Interaction			
F × V	**	*	NS

Means with the same letter(s) under the same column are not significantly different at P≤ 0.05 by DMRT.

Discussion

The tallest plants obtained with the application of foliar fertilizer (Super gro) at the rate of 2.0 L ha^{-1} could be attributed to the availability of sufficiently high content of macro and micro nutrients in the

foliar fertilizer which in turn provided the plants with required nutrient that may be insufficiently supplied through the root system in the soil. This finding is in conformity with the results of Shafeek *at al*. (2013) who reported that the superiority of highest levels of Stimufol foliar nutritional compound fertilizer at the highest levels of 200 g enhancing plant growth may be attributed to its high contents of macro and micro nutrients which provides the plants with required nutrients which one or more of them were insufficiently supplied through the root system in such low fertile soil. The authors also stated that foliar feeding is often the most effective and economical way to correct plant nutrient deficiencies. Abou-El-Nour (2002) reported that foliar application of nutrients could improve the nutrient utilization and lower environmental pollution through reducing the amounts of fertilizer added to soil.

Conclusion

From the results obtained it is concluded that the application of organo mineral fertilizer at the rate of 2.0 L ha^{-1} should be adopted in this agro ecological Zone.

Recommendation

It is recommended that farmers in this agro-ecological zone of Nigeria should adopt the application of (Super gro) at the rate of 2.0 L ha^{-1} for higher growth, yield and nutritional qualities of Amaranthus and Corchorus.

References

Abewoy D (2018). Review on Impacts of Climate Change on Vegetable Production and its Management Practices. Adv. Crop Sci. Tech 6:330. Doi:10.4172/2329-8863.1000330

Abou-El-Nour, E. A. A. (2002). Can supplemented potassium foliar feeding reduce the recommended soil potassium? *Pakistan Journal of Biological Science*, 5(3), 259 – 262.

Kabir MH (2015). Factors influencing adoption of integrated pest management (IPM) strategies by the vegetable farmers of Narsingdi district, Bangladesh. PhD thesis (published), University Science Malaysia, Penang 11800, Malaysia.

Keatinge JDH, Yang RY, Hughes d'A, Easdown WJ, Holme R (2011). The importance of vegetables in ensuring both food and nutritional security in attainment of the Millennium Development Goals. Food Sec. 3:491-501

Shahbandeh M (2020). Leading global producers of fresh vegetables 2017. Retrieved from https://www.statista.com/statistics/264662/topproducers-of-fresh-vegetables-worldwide

Ward AW (2016). *Encyclopedia Britannica.*

Shafeek, M. R., Helmy, Y. I., Nadia, M. O & Rizk, F. A. (2013). Effect of foliar fertilizer with nutritional compound and humic acid on growth and yield of broad bean plants under sandy soil conditions. *Journal of Applied Sciences Research*, 9(6), 3674 – 3680.

99 RESPONSE OF SESAME (*Sesamum Indicum L.*) TO DIFFERENT NUTRIENT SOURCES IN ANYIGBA, KOGI STATE NIGERIA

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Abstract

This field experiment was conducted during the 2021 cropping season at the Prince Abubakar Audu University Research and Demonstration farm, Anyigba. The study investigated the comparative effect of Cow dung (CD), Poultry manure (PM) and NPK fertilizer on the seed emergence, growth and yield of sesame. The research consisted of three sources of fertilizer (Cow dung, Poultry manure and NPK fertilizer), fifteen (15) treatments in total with each factor consisting of five levels of application (0, 150, 300, 450, 600 kg/ha) respectively. The experiment was laid out in a Randomized Complete Block Design (RCBD), with three (3) replications. Parameters measured include: Days to seedling emergence, plant height, number of leaves, number of branches, stem girth, number of capsules, fresh weight of capsules, dry weight of capsules and seed weight/plot. Growth and yield characters measured were significantly influenced by 300 kg/ha NPK fertilizer and 600 kg/ha of cow dung and 600 kg/ha poultry manure respectively. however, cow dung had no significant influence on number of capsule/plant. Highest seed yield was obtained at 600 kg/ha poultry manure and thus recommended. Alternatively, integrated use of 300kg/ha NPK + 600kg/ha PM will suffice for best performance given their complementary use.
Keywords: Cow dung, Integrated Nutrient Use, NPK fertilizer, Poultry manure, Sesame.

INTRODUCTION

Sesame (*sesame indicium L*) belongs to the family *Pedaliaceae*. The genus consists of about thirty-six species of which the most commonly recognized is *Sesame indicum* L popularly known as beniseed in Nigeria (Alegbejo *et al*., 2003). It is an erect, flowering annual plant which grows 50 cm to 250 cm tall or more, as determined by the soil or environmental conditions and varieties (Sharma, 2005). Sesame is usually propagated by seeds and matures in 70 to 120 days after sowing, depending on the variety (Indu and Savithri, 2003). Sesame originated from the tropical Africa where the greatest genetic diversity exists but was believed to have been introduced to India at a very early date, where a secondary Centre of diversity is well developed (; Olaoye 2007). Its cultivation is now extended beyond the tropical and subtropical zones to temperate and sub temperate zones of the world (Boureima *et al*., 2007). Sesame utilization includes human consumption, health treatments, beautification, livestock feeding and industrial uses (Sharma, 2005; El- Habbasa *et al*., 2007).

Sesame is produced mainly in savanna agro- ecological zones of Nigeria by small holders' farmers on relatively poor soils with limited inputs, thereby resulting in low average yield. Among the traditional sesame growers in Nigeria (particularly in the north central part), fertilizer application has not been a common practice because it is considered as a minor crop and can do well even on poor soils (Haruna and Usman, 2005). However, nutrition studies in the tropics have shown that the crop perform well with the applications of organic and/or inorganic fertilizers (Olowe and Busari, 2000; Okpara *et al*, 2007). The growth and yield of Sesame when fertilizer is not applied are generally low.

The average yield of sesame obtained by Nigerian farmers is reported to be 300 - 350 kg ha^{-1} in Nigeria when compared to Venezuela (1960 kg/ha), Saudi Arabia (1083 $kgha^{-1}$) (Okpara *et al*. 2007).

Manures such as cow dung and poultry manure are key fertilizers in organic and sustainable soil management. They contain many of the elements that are needed for plant growth and development. Apart from increasing soil fertility, manure serve as soil amendment by adding organic matter to the soil. Organic manure has also been reported to greatly improve water holding capacity, soil aeration, nutrient retention and microbial activity (Anonymous, 2007). Cow dung is an important source of nitrogen for crops. It helps farmers reduce inputs of commercial fertilizer, thereby increasing the profit margin of the farmers. Nutrients contained in cow dung are released more slowly and are stored for a longer time in the soil, thereby ensuring a long residual effect (Shama and Mittra, 1991) thus supporting better root, development, leading to high crop yields.

NPK fertilizer application on the other hand is an important option that should be adopted in order to improve crop yields in most soils of the Northern parts of Nigeria and most parts of Africa because Nitrogen, Phosphorus and Potassium are among the limiting nutrients of the savanna soils. Adequate supply of Nitrogen is beneficial for carbohydrates and protein metabolism, promoting cell division and cell enlargement.

Today in most part of Kogi State, specifically the eastern part of the state, little or no fertilizer have been implored in sesame production. However, Anyigba soil is generally known to be constrained with limiting Nitrogen and supplementary nutrient use is required to improve crop yield. Hence, the need to conduct performance evaluation on the nutrient sources to adduce a prescription on rates of application for optimum yield in this location. Therefore, the objective of this research was to determine the effect of different nutrient sources on the growth and yield of sesame at Anyigba.

MATERIALS AND METHODS

Description of the study site

This field study was conducted during the 2021 cropping season at the Prince Abubakar Audu University Research and Demonstration farm, Anyigba, Kogi State Nigeria. The State is situated on latitude 7^o 29' N and longitude 7^o 11' E on elevation of 420 m above sea-level. Anyigba is located within the Southern Guinea Savannah Ecological Zone of Nigeria. It is characterized by an average rainfall of about 180 mm per annum mostly distributed between the months of April and October. Mean monthly minimum and maximum temperature of about 17^o C and 36.2^o C respectively. The soils generally are sandy to sandy-loam. Mean Monthly temperature varies between 15.1^o C and 31.3^o C. (Metrological Station Data, 2019).

Treatment and Experimental Design

Soil sample from the experimental location was obtained using tubular auger, bulked and analyzed for its physio-chemical properties at the Soil and Environmental Management Laboratory, Prince Abubakar Audu University, Anyigba (results presented in table 1). N, P & K composition of cow dung and poultry manure used in the experiment was also analyzed and result presented in table 2.

The experiment consisted of a total of 15 treatments laid in a Randomized Complete Block Design (RCBD) with three replications. Treatments consisted of cow dung, poultry manure and NPK 15:15:15 fertilizer, each applied at varying rates; 0 kgha^{-1}, 150 kgha^{-1}, 300 kgha^{-1}, 450 kgha^{-1}, and 600 kgha^{-1} respectively. Forty-five plots (15 x 3) were obtained in total, each measuring 3m x 4m (12m^2). Each plot was separated by 0.5 m discard row to minimize variation within replications. Each replication was also spaced 1.0 m apart to minimize inter replication variation. Treatments were assigned equally to every plot with a random number system to avoid biasness. Total land area used for the experiment measures 67.5m x 11.0m = 742.50m^2 (0.0743ha). Sesame seeds (variety E-8) and NPK fertilizer were sourced from Kogi State Agricultural Development Project (ADP), Anyigba branch office. Cow dung and poultry manure was obtained from Kogi State University Livestock Teaching and Research Farm. Sowing was done on ridges of 75cm apart by means of seed drilling at rate of 5kg/ha and a depth of 1.5 cm as described by Bruno (2014). Cow dung and Poultry manure was incorporated into the soil and then left on the field to decompose into the soil for two weeks, before sowing the sesame seeds since they are slow in releasing nutrients to the soil, NPK fertilizer was applied to the plots at the time of sowing.

Cultural practices

Weed Control

Weeding was done manually by simple hand pulling at every point of appearance on the plots The inter plot weeds and discard rows were hoed.

Insect Pest and Disease Control

No visible insect pest was observed during the period of the experiment, however, experimental field was kept drained to prevent root and stem diseases associated with waterlogging and damping-off diseases.

Data Collection and Analysis

Data was collected on the following growth and yield parameters; germination count, plant height, number of leaves, stem girth, number of branches/plant, capsules/plant, fresh capsule weight/plant, dry capsule weight/plant and seed weight/plant.

Data collected were subjected to Analysis of Variance (ANOVA) as outlined by Steel and Torrie (1980). Separation of treatment means for significant effect was done using the fishers least significant difference (F-LSD)

RESULTS

Table 1. Physio-chemical Characteristics of the soil sample taken from the experimental site before the conduct of the experiment

Soil characteristics	Depth (0 – 30cm)
Particle size fraction	
Sand (%)	85
Silt (%)	9.6
Clay (%)	4.4
Textured class	Sandy-loam
pH (H_20)	5.3
Organic Matter (%)	15.5
Total Nitrogen (%)	0.87
Available P (mg/kg)	5.35
Exchangeable K (cmol/kg)	0.17
C.E.C (cmol/kg)	10.13

Table 2: N, P & K composition of cow dung and poultry manure used in the experiment

Chemical composition	Cow dung (%)	Poultry manure (%)
Nitrogen	1.56	1.98
Phosphorus	1.9	3.12
Potassium	1.06	1.11

Source: Soil and Environmental Management Laboratory, Faculty *of Agriculture, Kogi State University, Anyigba.*

Effect of Cow dung, Poultry manure and NPK Fertilizer on Growth characters of Sesame crop in Anyigba Kogi State.

Results obtained for application of Cow Dung, Poultry Manure and NPK fertilizer on growth characters of sesame is presented in table 3.

There were significant differences in heights of plants when treated with CD, PM & NPK fertilizer. Application of 600, 450 & 300kgha^{-1} CD gave taller plants which are statistically at par to each other. Control plots and application of 150 kgha^{-1} gave shorter plants while behaving alike. Similarly, 600 & 450 kgha^{-1} PM gave taller plants in the same manner followed by application of 300 & 150 kgha^{-1} of PM. Control plots gave the shortest height of sesame.

Application of 300 kgha^{-1} of NPK fertilizer produced the tallest plants (305.3cm) followed by 450 & 150 kgha^{-1} NPK which are significantly not different from each other. However, application of 150 kgha^{-1} NPK produced shorter plants.

Application of 600 kgha^{-1} CD gave plants which higher leaf numbers, this was however not significantly different from number of leaves produced when 450 & 300 kgha^{-1} CD was applied. Similarly, leaf numbers produced when 0, 150 & 300 kgha^{-1} CD was applied are statistically the same. PM behaved the same way as CD application. However, 300 kgha^{-1} of NPK produced crops with the highest number of leaves followed by application of 150 & 450 kgha^{-1} NPK. 600 kgha^{-1} and control plots gave the least number of leaves which are statistically at par.

Application of 600 & 450 kgha^{-1} CD produced higher number of branches which are significantly not different from each other, control plots, 150 & 300 kgha^{-1} CD responded in the same manner as they gave the same number of branches. PM fertilization behaved in the same manner with application of CD. NPK influenced branch number significantly as application of 300 $kgha^{-1}$ produced plants with the highest number of branches which is significantly different from other NPK application rates. this was followed by 150, 450 & 600 0 $kgha^{-1}$ respectively. Control plots gave the lowest number of branches.

CD, PM and NPK Fertilizer significantly influenced ($P \leq 0.05$) the girth od sesame stems as presented in table 3. Application of 600 $kgha^{-1}$ CD produced plants with thicker stems. However, this result was not significantly different from those obtained when 450 & 300 $kgha^{-1}$ CD was applied. In the same manner, 450, 300 & 150 $kgha^{-1}$ produced the same girth sizes of stems statistically. Control plots produced the thinnest stem girth.

Similarly, PM application behaved alike with CD application. 600 $kgha^{-1}$ PM produced plants with thicker stems. This was statistically at par with those produced when 450 and 300 $kgha^{-1}$ PM was used. Control plots also produced the thinnest stem girth.

Application of 300 $kgha^{-1}$ NPK produced the thickest stem girth which was significantly different from other rates. 450 & 600 $kgha^{-1}$ produced girths which are statistically the same. Also, control plots and application of 150 $kgha^{-1}$ NPK gave the least girth sizes which are also at par to each other.

Table 3: Effect of CD, PM and NPK Fertilizer on growth characters of sesame crop in Anyigba environment.

Treatments ($kgha^{-1}$)	Weeks after sowing			
	Plant height (cm)	Number of leaves/plant	Number of Branches/plant	Stem girth (cm)
CD				
0	218.85b	157.65c	110.0b	4.50c
150	238.15b	169.30bc	114.95b	4.63bc
300	252.2a	177.95abc	117.9b	4.85ab
450	259.75a	195.95ab	144.55a	4.90ab
600	273.30a	210.65a	153.7a	4.95a
F-LSD$_{(0.05)}$	29.1	32.9	11.2	0.30
PM				
0	221.85c	157.75c	112.50b	4.50c
150	247.30b	179.65bc	120.80b	4.65bc
300	253.90b	188.65abc	127.90b	4.85abc
450	263.10ab	209.85ab	150.00a	4.95ab
600	279.05a	216.80a	163.30a	5.05a
F-LSD$_{(0.05)}$	24.8	32.9	18.8	0.40
NPK				
0	221.85c	157.85d	111.90e	4.50c

150	268.45b	330.0b	234.10b	4.70c
300	305.30a	412.0a	289.50a	6.40a
450	273.35b	264.0c	190.40c	5.45b
600	230.55c	201.3cd	146.65d	5.35b
F-LSD$_{(0.05)}$	29.0	64.0	18.2	0.25

Means with similar letter(s) in the column are not significantly different at probability level of 0.05

Table 4: Effect of CD, PM and NPK Fertilizer on yield characters of sesame crop in Anyigba environment.

	Yield Characters					
	Number of capsules/plants			Fresh capsule weight (g/plot)		
Treatments (kgha^{-1})	Fertilizers			Fertilizers		
	CD	PM	NPK	CD	PM	NPK
0	43.3	43.3b	43.3b	24.5b	24.5bc	24.5d
150	44.3	56.6a	76.6a	24.6b	25.8b	61.1b
300	46.6	58.3a	86.6a	27.2b	29.3ab	66.9a
450	48.3	60.0a	73.3a	27.8b	31.8a	45.6c
600	51.6	63.3a	48.3b	34.2a	35.0a	30.9d
LSD $_{(0.05)}$	ns	8.5	16.3	5.8	6.2	5.7
C.V (%)	27.63	17.06	28.25	25.32	24.06	25.96

Means with similar letter(s) in the column are not significantly different at probability level of 0.05

Table 4 shows the effect of CD, PM & NPK on the number of capsule/plant and fresh capsule weight of sesame crop in Anyigba environment. Cow dung application had no significant influence ($P \geq 0.05$) on capsules/plant. However, poultry manure and NPK fertilizer significantly influenced ($P \leq 0.05$) number of capsules produced per plant. Application of 600 kgha^{-1} of PM gave the highest number of capsules/plant (63.3), this was however not significantly different from those obtained when 450 kgha^{-1}, 300 kgha^{-1} and 150 kgha^{-1} of PM was applied. Control plots gave the least number of capsules (43.3).

Application of 300 kgha^{-1} of NPK gave the highest number of capsules/plant (86.6) this was however not significantly different from those obtained with 150 kgha^{-1} and 450 kgha^{-1} NPK application. Control plots and application of 600 kgha^{-1} of NPK gave the least number of capsules.

Similarly, CD, PM, & NPK significantly influenced fresh capsule weight of sesame crop in Anyigba environment (table 4).

Application of 600 kgha^{-1} of CD produced the highest weight of fresh capsule (34.2g), all other levels of application including the control pots are statistically at par.

Application of 600 kgha^{-1} PM also produced the highest capsule weight (35.0g). However, this result is not significantly different from those obtained when 300 kgha^{-1} and 450 kgha^{-1} PM was applied. Control plots and 150 kgha^{-1} PM gave the lowest fresh capsule weight (24.5g, 25.8g).

Alternatively, application 300 kgha^{-1} of NPK fertilizer produced the highest capsule weight (66.9g) which was significantly different from other application rates. this was followed by 150 kgha^{-1} (61.1g), 450 kgha^{-1} (45.6g) in that order. However, control plots and 600 kgha^{-1} NPK application produced the least shoot weight (24.5g, 30.9g).

Table 5: Effect of CD, PM and NPK Fertilizer on yield characters of sesame crop in Anyigba environment.

	Yield characters					
	Dry weight of capsules (g/plot)			Seed Yield (g/plot)		
Treatments (kgha^{-1})	Fertilizers			Fertilizers		
	CD	PM	NPK	CD	PM	NPK
0	11.4d	11.4c	11.5c	6.5e	6.5c	6.5c
150	13.8c	14.8b	25.6b	7.1d	7.4c	13.6a
300	15.1bc	15.3ab	32.7a	7.6c	8.0bc	14.8a
450	15.4ab	16.3ab	24.1b	7.9b	9.8b	11.0b
600	16.9a	17.1a	14.3c	8.2a	16.6a	7.2c
LSD $_{(0.05)}$	1.5	2.05	5.8	0.3	0.41	2.1
C.V (%)	16.34	15.85	28.15	5.20	17.12	22.52

Means with similar letter(s) in the column are not significantly different at probability level of 0.05

Table 5 shows the effect of CD, PM & NPK on the dry capsule weight and seed yield of sesame crop in Anyigba environment. Application of 600 kgha^{-1} CD produced the highest dry weight of capsules (16.9g). this result was however not statistically significantly different from those produced when 450 kgha^{-1} of CD was applied (15.4g). similarly, 300 kgha^{-1} and 150 kgha^{-1} of CD produced dry capsule weight that are statistically at par to each other. Control pots, gave the lowest dry capsule weight (11.4g).

Similarly, 600 kgha^{-1} PM gave the highest dry capsule weight (17.1g) which was statistically at par with those obtained when 450 kgha^{-1} and 300 kgha^{-1} PM was applied. Additionally, 150 kgha^{-1}, and 450 kgha^{-1} PM application produced weights that are statistically at par as control pots (0 kgha^{-1}) gave the least result (11.4g).

NPK fertilizer produced dry capsule weight higher than both organic fertilizers used. Application of 300 kgha^{-1} of NPK produced plants with the highest dry capsule weight (32.7g). This was followed by 150 kgha^{-1}, 450 kgha^{-1} and 600 kgha^{-1} in that order. Application of 150 kgha^{-}

^{1} and 450 kgha^{-1} gave capsule weight that are statistically at par. However, control plots and 600 kgha^{-1} gave the least yield.

Results obtained (table 5) showed that PM influenced the highest seed yield. application of 600 kgha^{-1} PM produced the highest seed yield (16.6g). this was significantly different from other PM application rates. application of 300 kgha^{-1} and 450 kgha^{-1} produced yield that are not significantly different from each other. Similarly, seed yield obtained when 300 kgha^{-1}, 150 kgha^{-1} and 0 kgha^{-1} was applied are statistically at par.

CD applied at 600 kgha^{-1} gave the highest seed yield followed by 450 kgha^{-1}, 300 kgha^{-1}, 150 kgha^{-1} application rates in that order. control plots gave the least yield. similarly, NPK fertilizer applied at 300 kgha^{-1} gave the highest seed yield. however, this was not significantly different with those obtained with 150 kgha^{-1} NPK application. Application of 450 kgha^{-1} gave yield following 300 kgha^{-1} NPK application. 600 kgha^{-1} and control plots gave the least yield.

Discussion

Significant increases recorded on both growth and yield characters of sesame crop shows that the crop performs well with the application of organic or inorganic fertilizers, this is in agreement with Olowe and Busari, (2000), Okpara *et al.*, (2007). Significant influence of organic (CD, PM) and inorganic (NPK) fertilizers on plant height, stem girth, number of branches and number of leaves has been reported Ojonugwa *et al*, (2022), Chukwu *et al.*, (2012), Agbede (2009). The influence of yield characters and yield on application of organic and inorganic characters has also been reported in many researches. Haruna and Aliyu (2012) reported that yield and economic returns of sesame were better with the applications of 5 t ha^{-1} of poultry manure, 60 kg ha^{-1} of Nitrogen. From this research, 600kg/plot of Poultry manure produced the highest seed yield. this is supported by Vaiyapuri *et al*. (2004).

All growth and yield characters measured responded best to 300kg/ha NPK fertilizer throughout the sampling periods of the experiment. However, these responses do not translate to seed yield. this is a clear indication that N released from inorganic fertilizer helps to improve organic matter decomposition and function in soil organic amendment which produced a better organic condition for highest seed yield (as evident by PM application) but NPK in its entirety only showcased this effort on growth and yield characters. This assertion is supported by Adeniyan and Ojeniyi (2003), Duhoon *et al.*, (22004), Hossain *et al.*, (2007) who asserted that lower rates of NPK could lead to incomplete organic matter decomposition resulting from enhanced soil microorganisms as N release from component NPK fertilizer enhanced soil microbial activities thus increasing nutrient concentration of soil necessary for optimum yield. this is also supported by Jakusko and Usman (2013) who reported highest yield components in sesame from application of 300kg/ha NPK fertilizer in Northeastern Nigeria.

CONCLUSION

Organic fertilizer rates (CD & PM) and inorganic fertilizers (NPK) has proven effective in overall growth yield of sesame crop in Anyigba environment. Comparatively, growth and yield characters responded best to the application of 300kg/ha NPK which does not translate to final seed yield. alternatively, Poultry manure application at 600kg/ha gave the highest seed yield and thus recommended. For optimum growth seed yield, most literatures have recommended application of both organic and inorganic fertilizers due to its complementary benefits as evident by this research. Therefore, application of 300kg/ha NPK or 600kg/ha PM is suggested for best sesame performance at Anyigba.

AUTHOR CONTRIBUTIONS

This research was jointly conducted by all the authors mentioned in this manuscript. Authors Yusuf, M. and Akowe, I. I. designed this study, initiate the protocols and data interpretation. Author Yusuf, M. supervised and anchored the field work, obtained field data and performed preliminary data analysis. Authors Beida, A S., Iyaji, J., Abdulhakeem, S. & Alao, A. O. managed the literature searches and review to produce the initial draft. Final manuscript was read and approved by all the authors.

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REFERENCES

Abubakar, S. S., Onyibe, J. E & Tologbonshein, E. B. (1998). The role of extension, research and information dissemination in enhancing benniseed production and marketing for resources poor farmers. *Proceedings of the first workshop on Benniseed held at the National Cereal Research Institute, Baddegi, Nigeria*, March 3rd - 5th 1998. Pp 86- 89.

Adeniyan, O. N., & Ojeniyi, S. O. (2003). Comparative effectiveness of different levels of poultry manure with NPK fertilizer on residual soil fertility, nutrient uptake and yield of maize. *Moor Journal of Agricultural Research*,*4*(2), 191-197.

Agbede, O. O. (2009). *Understanding Soil and Plant Nutrition Salman.* Press & Co. Nig. Ltd. Keffi, Nigeria 260pp.

Alegbejo, M. D., Iwo, G. A., Abo, M. E & Idowu, A. A. (2003). *Sesame production Pamphlet*; A potential industrial and Export oil seed crop in Nigeria. 59-76pp

Ali, A., Kafikafi U., Yamaguchi L., Sugimoto, Y. & Inanga, S. (2000). Growth, transpiration, root

- boron, cytokinins and gibberellins and nutrient compositional changes in sesame exposed to low root –zone temperature under different ratios of nitrate: Ammonium supply. *Journal of plant Nutrition* 23, 123-140.

Anonymous (2007). Effect of organic and inorganic nutrient sources on Soil Minerals Nitrogen and maize yields in Western Kenya. https://www.agnet.org

Boureima, S., Diout, M., Diop, T. A., Diatta, M., Leye, E. M., Ndiaye, F. & Seck, D. (2007). Effects of arbuscular mycorrhiza in Oculation on the growth and the development of sesame (*Sesame indicum* L.) *African Journal of Agricultural Research*, 3(3), 234 – 238.

Bruno, D. (2014). Farmer's guide for the production and post-harvest handling of sesame products in Nigeria in: *Expanding export of sesame seed and sheanut/butter through improved SPS capacity building for public and private sectors, A training Manual*. STDF Project 172 co-financed by NEPC and STDF, implemented by NEPC and supervised by ITC. Pp. 1 – 48.

Chukwu, L. I., Ano, A. O. & Asawalam, D. O. (2012). Effects of poultry manure and NPK fertilizer on soil properties and nutrient uptake of maize (*Zea mays* L.) plants growth in an Ultisol. Proceedings of the 36th Annual Conference of the Soil Science Society of Nigeria (SSSN) on 7th –11th March. University of Nigeria Nsukka.

Duhoon, S. S., Jyotishi, A., Deshmukh, M. R., & Singh, N. B. (2004, September). Optimization of sesame (*Sesamum indicum* L.) production through bio/natural inputs in: *Proceedings of the 4th International Crop Science Congress Brisbane, Australia* Vol. 26.

El-Habbasa, S. F., Abd-El-salam, M. S and Kabesh, M. O (2007). Response of two sesame varieties (Sesame indicum L.) to partial replace of chemical fertilizers by bio-organic fertilizer. *Research Journal of Agriculture and Biological Sciences,* 3(6), 563 – 571.

Haruna I. M & Usman, A. (2005) Agronomic practices that enhances increased yield and seed quality of sesame (*Sesamum indicum L.*) *A paper presented at the Agric. Transformation Day (Sesame and rice) organized by OLAM Nig. Ltd. Held at Agro Miller Ltd. Compound, Uni-Agric. Road, Makurdi,* 4th Feb; 2005.

Haruna I M. & Aliyu, L. (2012). Seed yield and economic returns of sesame (*Sesamum indicum* L.) as influenced by poultry manure, nitrogen and phosphorus fertilization at Samaru, Nigeria. *Revista Científica UDO Agrícola*, 12 (1), 152 - 156.

Hossain, M. A., Hamid, A., & Nasreen, S. (2007). Effect of nitrogen and phosphorus fertilizer on N/P uptake and yield performance of groundnut (*Arachis hypogaea* L.), *Journal of Agricultural Research (Pakistan)*.

Indu, K. P & Savithri, K. E. (2003). Effect of Bio-fertilizers vs perfected chemical fertilization for sesame grown in summer rice fallow. *Journal of Tropical Agriculture, Ibadan Nigeria. IITA Manual series*, No.7.

Jakusko, B. B., & Usman, B. D. (2013). Effects of NPK fertilizer and plant population density on productivity of sesame (Sesamum indicum L.), *Research Journal of Agricultural and Environmental Management, 2*(5), 121-126.

Obi, I. U. (2001). *Introduction to factorial Experiments for Agricultural, Biological and Social Sciences Research.* 2nd ed. Nigeria: Optimal Int. Ltd. 45p

Ojonugwa, J. A., Musa, U.T., Yusuf, M. (2022). Influence of farm yard manure and N-levels on the growth, yield characters and yield of sesame (*Sesamum indicum* L.). *Journal of Innovative Agriculture, 9(1), 6 – 10. doi: 10.37446/jinagri/rsn/9.1.2022.6-10.*

Okpara, D. A, Maoneke, C. O and Ojikpong, T. O (2007). Effect of nitrogen and phosphorus fertilizers rates on the growth and yield of sesame (*Sesamum indicum* L.) in the southern eastern rainforest belt of Nigeria. *Nigeria Agricultural Journal* 38, 1 - 8. 45pp.

Olaoye, S. F. (2007). The Effects of Phosphorus Fertilizer Application on the Growth, seed yield and quality of sesame (*Sesamum indicum L.*) varieties. B. Tech, Ogbomoso P.47.

Olowe, V. I. O and Busari, 2000. Response of Sesame (*Sesamun indicum L*) to nitrogen and phosphorus application in southern guinea savanna of Nigeria. *Trop. Oil seeds Journal:30-37.*

Sharma, P.B. (2005). Fertilizer management in sesame (*Sesamum indicum L.*) based intercropping system in Tawab Command area. *Journal of Oil Seeds Research*, 22, 63 – 65.

Sharma, A. R. and Mittra, B. N. (1991) effect of different rates of application of organic and nitrogen fertilizer in a rice based cropping system. *Journal of agricultural Science*, 1991, 117, 313-318.

Steel, R. G. D., Torrie, J. H. (1997). *Principles and Procedures of Statistics*. McGraw Hill Book Co., NY. USA.

Vaiyapuri, V.A., Amudha, M. V., Sriramachandrasekharan & V. Imayavaramban. (2004). Effects of Sulphur levels and organic amendments on the growth and yield of sesame. *Advances in Plant Sciences* 17 (2), 681 – 685.

100 EFFECTS OF INTEGRATED NUTRIENT MANAGEMENT ON WEED INFESTATION AND YIELD OF SOYBEAN IN SOUTHERN GUINEA SAVANNA ZONE OF NIGERIA

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Abstract

Field trials were conducted at Lapai, Minna and Mokwa Local Governments area of Niger State, Nigeria to evaluate the effects of integrated nutrient management on weed growth and yield of soybean. The study was aimed to determine the effects of integrated nutrient management on weed infestation and yield of soybean. The treatments were: - No-input, Farmers practice (NPK only) at the rate of 200 kg/ha, Agric Lime at the rate of 0.5 tons ha^{-1} + NPK at 200 kg/ha, Agric Lime at the rate of 0.5 tons ha^{-1} + Farmyard manure at the rate of 5 tons ha^{-1} + NPK at the rate of 200 kg ha^{-1} and Farmyard manure at the rate of 5 tons ha^{-1} + NPK at the rate of 200 kg ha^{-1} arranged in a randomized complete block design (RCBD) and replicated three times. Results revealed that, the important weed species of soybeans are Hyptis suaveolens, Tridax procumbens, Digitaria horizontalis, Paspalum scrobiculatum and Commelina benghalensis. Application of No-input reduced weed infestation than in terms of weed density and dry weight. The application of combination of Agric lime + Farm Yard Manure + NPK increased the grain yield of soybean by 56.5 %, 95.3%, 80.0% and 77.4 % in Lapai, Minna, Mokwa and across the location, respectively. It is recommended that farmers in this agro-ecological zone of Nigeria should apply Agric lime + Farm Yard Manure+ NPK for higher soybean yield.

Keywords: Agric lime, Farmyard manure, Integrated nutrient, Soybean, Weed species,

INTRODUCTION

Soybean [*Glycine max* (L.) Merril] is an important crop commodity widely grown and utilized as a main food source for humans, feed for livestock and as a raw material for oil production (Mamia *et al.*, 2018). At present in tropical Africa, the average seed yield of soybean is below 1 t ha^{-1} as against the world average of 2.7 t ha^{-1} (FAO, 2016). General low yields of food crops in the tropics have been attributed to low soil fertility status, weed infestation, rising cost of agrochemicals, low purchasing power of resource-constrained farmers, lack of improved crop varieties, lack of access to necessary inputs, poor management practices among others (Zerihun and Haile, 2017).

Weeds are a unique group of plants species that infest and thrive in intensively disturbed habitats. In farmlands, weeds compete with crops for most abiotic resources such as nutrients, light and water, and their presence usually results in drastic decline in crop yield and quality. The magnitude of crop yield reduction can be influenced by the weed density, types of weed species present in the field, as well as the weed species persistence and the type of cultural practices in use in the farmland (Kaur and Verma, 2016).

The continuous application of inorganic fertilizer is known to decrease the water holding capacity, organic matter and nutrient content, and the soil microbe population which in turn can decrease the quality of soil fertility (Zerihun and Haile, 2017). Declining soil fertility is one main reason for the slow growth in food production in Sub-Saharan Africa (Zerihun and Haile, 2017). In the same vein, the productivity of soybean is limited due to poor soil and crop management practices. As a result, smallholder farmer yield for the crop is far below the potential production.

However, use of organic manure alone or in combination with chemical fertilizer can improve the physical and chemical properties of the soils; which in turn can provide a good substrate for the growth of microorganisms, and in maintaining a favourable nutritional balance (Gautam and Pathak, 2014). One of such strategy to maintain soil fertility for sustainable soybean production is through the judicious use of fertilizers for higher crop yield (Mamia *et al*., 2018). It has also been reported that the application of combination of inorganic and organic fertilizers increased soybean yield by 3.5 t ha^{-1} (Yamika and Ikawati, 2012). In order to optimize and maintain healthier soil and achieve sustainable soybean production, we suggest the integration of ameliorant (organic manure and lime) and inorganic fertilizers. Therefore, the objective of this study was to determine the effects of combining NPK fertilizer, agric lime and farmyard manure on weed growth and yield of soybean.

MATERIALS AND METHODS

On farm study was conducted in Lapai, Minna and Mokwa Local Government of Niger State, located in the Guinea savannah zone of Nigeria. The treatments were (No-input, Farmers practice (NPK only) at rate of 200 kg/ha, Agric Lime at the rate of 0.5 tons ha^{-1} + NPK at 200 kg/ha, Agric Lime at the of 0.5 tons ha^{-1} + Farmyard manure at the rate of 5 tons ha^{-1} + NPK at the rate of 200 kg ha^{-1} and Farmyard manure at the rate of 5 tons ha^{-1} + NPK at the rate of 200 kg ha^{-1}) arranged in a randomized complete block design (RCBD) and replicated three times. The soybean seed variety TGX 1987-6f was sourced from the National Cereals Research Institute (NCRI) Badeggi, Niger State. This variety is early maturing and high yielding. Farm yard manure and Agric. lime were sourced in Minna, Niger State and NPK cherifien des- phosphate (OCP) fertilizer was sourced from Morocco where it is manufactured. Lime and manure were applied one week before planting by incorporating them into the soil according to the treatment combinations. Manual weeding was done at 3 and 6 WAS. The NPK fertilizer was applied at 3 WAS by side placement 5 cm away from the plant stands. Soybean was sown at 3 seeds per hole and later thinned to 2 plants per stand at 14 days after planting. The parameters measured were weed importance value index (IVI), weed density and weed dry weight at 9 WAS, number of pods per plant and grain yield. Data collected were subjected to analysis of variance (ANOVA) using the Statistical Analysis System (SAS) version 9.2 software. The Least Significant Difference (LSD) test was used to separate the treatment means at 5% level of significance.

RESULTS AND DISCUSSION

Fourteen, thirteen and eight weed species from 10 different families were identified in soybean across the integrated nutrient management at 9 WAS in Lapai, Minna and Mokwa, respectively (Table 1). Based on the importance value index (IVI), the prevalent weed species infesting soybean field in all the locations were *Hyptis suaveolens, Tridax procumbens, Digitaria horizontalis, Paspalum scrobiculatum* and *Commelina benghalensis* (Table 1). Similarly, weed species such as *Sida acuta, Cyperus rotundus, Vernonia galamensis, Dactyloctenum aegyptium* and *Kyllinga pumila* were predominant in Lapai and Minna only than the other weed species (Table1). In general, five weed species, *Hyptis sua veolens, Tridax procumbens, Digitaria horizontalis, Paspalum scrobicula-tum* and *Commelina benghalensis* were the most important and prevalent in soybeans in our study. This suggests the ecological importance of these weed species and their ability to compete favourably with soybeans for growth resources. Our observations also suggest that the variation in the number of weed species identified during the sampling period might be attributed to the fact that weed species and crops are site specific over a wide range of habitat (Dada *et al*., 2017).

Weed density differed significantly among the integrated nutrient management at Lapai, Mokwa and the mean (Table 2). Plots with No-input produced the lowest weed density than all the other plots. The application of Agric lime + Farm Yard Manure + NPK produced higher weed density across the locations and the mean. Weed dry weight differed significantly among the integrated nutrient management in Lapai, Minna, Mokwa and the mean (Table 2). The plots with No-input had lighter weed dry weight than all the other plots. Plots with the combined application of Agric lime + Farm Yard Manure + NPK produced heavier weeds in each location and the mean.

Table 1: Weed species composition and their importance value index average across the integrated nutrient management at 9 WAS in Lapai, Minna and Mokwa

		Important value index		
Weed species	Family	Lapai	Minna	Mokwa
Sida acuta Burm.f.	Malvaceae	10.92	14.97	-
Cyperus rotundus L.	Cyperaceae	10.75	42.70	-
Hyptis suaveolens Poit.	Lamiaceae	27.78	18.77	36.33
Tridax procumbens L.	Asteraceae	25.35	54.80	60.61
Digitaria horizontalis Willd.	Poaceae	31.36	20.59	62.05
Paspalum scrobiculatum L.	Poaceae	28.56	14.97	31.18
Commelina benghalensis L.	Commelinaceae	18.39	45.77	25.13
Vernonia galamensis (Cass.) Less	Asteraceae	11.34	12.04	-
Dactyloctenum aegyptium (L.) P. Beauv	Poaceae	12.77	14.97	-
Kyllinga pumila Michx.	Cyperaceae	47.44	14.97	-
Panicum maximum Jacq.	Poaceae	49.46	-	-
Calopogonium mucunoides Desv.	Papilionoideae	8.62	-	25.70
Cynodon dactylon (L.) Pers	Poaceae	8.62	-	-
Mitracarpus villosus (Sw.) DC.	Rubiaceae	8.62	-	-
Pennieitum pedicellatum Trin.	Poaceae	-	-	31.18
Daniellia oliveri (Rolfe) Hutch. & Dalz.	Fabaceae	-	-	27.92
Senna occidentalis (L.) Link	Fabaceae	-	14.97	-
Ageratum conyzoides Linn.	Asteraceae	-	15.45	-
Ludwigia decurrens Walt.	Onagraceae	-	14.97	-

Table 2: Weed density and dry weight at 9 WAS in soybean as affected by integrated nutrient management in 2021 rainy season at Lapai, Minna and Mokwa

	Weed density (no. m^{-2})				Weed dry weight (g m^{-2})			
Treatment	Lapai	Minna	Mokwa	Mean	Lapai	Minna	Mokwa	Mean
No-Input	6.0c	5.0a	0.48b	4.0d	1.03d	1.13b	2.00b	1.40d
NPK only	9.0bc	5.0a	0.57a	5.0cd	1.50c	1.80ab	5.33a	2.90bc
Agric lime + NPK	13.0bc	7.0a	0.57a	7.0bc	2.47b	2.50a	5.33a	3.34ab
Agric lime + Farmyard manure + NPK	21.0a	7.0a	0.57a	10.0a	3.20a	2.72a	5.67a	3.90a
Farmyard manure + NPK	16.0ab	7.0a	0.56a	8.0ab	2.42b	2.14a	4.33a	2.10cd
LSD (0.05)	7.81	2.97	0.53	2.61	0.40	0.99	2.28	0.80

Means with the same letter(s) within the same column are not significantly different from each other using the least significant difference (LSD) test at P≤ 0.05

Table 3: Number of pods and grain yield of soybean as affected by integrated nutrient management in 2021 rainy season at Lapai, Minna and Mokwa

	Number of pods per plant				Grain yield (kg ha^{-1})			
Treatment	Lapai	Minna	Mokwa	Mean	Lapai	Minna	Mokwa	Mean
No-Input	176.0c	273.0c	230.0c	226.0c	833.33b	92.27e	361.10d	430.23e
NPK only	263.0c	347.0c	367.0c	326.0c	1037.03b	979.20d	962.93c	990.72d
Agric lime + NPK	480.0b	659.0ab	574.0b	571.0b	1509.27a	1361.10c	1268.58bc	1379.62c
Agric lime + Farmyard manure + NPK	745.0a	786.0a	812.0a	781.0a	1916.67a	1981.50a	1805.53a	1901.23a
Farmyard manure + NPK	526.0b	587.0b	669.0ab	594.0b	1638.87a	1685.20b	1574.10ab	1632.72b
LSD (0.05)	141.21	182.86	159.92	181.51	466.55	252.47	358.93	179.22

Means with the same letter(s) within the same column are not significantly different from each other using the least significant difference (LSD) test at P≤ 0.05

The higher weed density and heavier weeds recorded with the application of Agric lime + FYM + NPK could be attributed to the availability of nutrients in sufficient quantity, and as at when required to support the growth and development of the weeds. This finding is in line with the work of Lukangila (2016) who reported that the application of mineral and organic fertilizers can increase weed pressure either by strengthening the growth of weed seedlings present at the time of the fertilizer application or by stimulating seed germination from seed stock of the past growing season.

Number of pods per plant were significantly different among the integrated nutrient management in this study (Table 3). The application of Agric lime + Farm Yard Manure + NPK significantly produced more pods per plant compared to the other plots. Plots with No-input produced the least pods per plant in each location and mean. Soybean grain yield differed significantly among the integrated nutrient management in all the locations and the mean (Table 3). Plots with the application of Agric lime + Farm Yard Manure + NPK produced the highest grain yield than all the other plots. The plot with No-input had the lowest grain yield in this study. The production of more pods per plant and higher grain yield by the application of Agric lime + FYM + NPK might be attributed to the improvement of the soil physical and chemical properties by the soil amendment and organic manure in providing a favourable medium for the uptake of inorganic fertilizer which in turn supported the increase in the yield and yield characters of soybean. This finding is in conformity with the work of Mamia *et al.* (2018) who reported maximum number of pods per plant, number of seeds per pod, pod length and seed yield of soybean due to adequate supply of nutrient element at the right time from organic and inorganic sources and consequently increased the yield and yield attributes of soybean.

CONCLUSION

From the results of this study, it is concluded that weed species associated with soybean include *Hyptis suaveolens, Tridax procumbens, Digitaria horizontalis, Paspalum scrobiculatum* and *Commelina benghalensis.* Application of combination of Agric lime + Farm Yard Manure + NPK resulted in the production of highest grain yield of soybean and therefore recommended to soybean farmers in this zone of Nigeria.

References

Food and Agriculture Organization (2016). Soybeans, yield (hectogram per hectare) for all countries. www.factfish.com/statistic /soybean%2C%20yield.

Gautam, S. S. & Pathak, N. (2014). Effect of organic fertilizers on soybean yield in Bundelkhand. *Technofame*, 3, 84 - 87.

Kaur, C. & Verma, G. (2016). Effect of different organic sources and their combinations on weed growth and yield of wheat (*Triticum aestivum*). *Indian Journal of Agricultural Research*, 50, 491 - 494.

Lukangila, M. A. B. (2016). Response of weeds and crops to fertilization alone or in combination with herbicides: A Review. *American Journal of Plant Nutrition and Fertilization Technology*, 6(1),1 – 7.

Mamia, A., Amin., A. K. M. R., Roy, T. S & Faruk, G. M. (2018). Influence of inorganic and organic fertilizers on growth and yield of soybean. *Bangladesh Agronomy Journal*, 21(1), 77 - 81.

Yamika, W. S. D & Ikawati, K. R. (2012). Combination inorganic and organic fertilizer increased yield production of soybean. *American-Eurasian Journal of Sustainable Agriculture*, 6 (1), 14 - 17.

Zerihun, A & Haile, D. (2017). The effect of organic and inorganic fertilizers on the yield of two contrasting soybean varieties and residual nutrient effects on a subsequent finger millet crop. *Agronomy*, 7(42), 1 – 15.

101 EFFECT OF MILLED GROUNDNUT SHELL AS A NUTRIENT SOURCE ON THE NUTRITIONAL QUALITY OF PEPPER IN COMPARISON WITH OTHER NUTRIENT SOURCES

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Abstract

Many nutrient sources have been introduced into agriculture such as poultry manure, cow dung, NPK, urea etc. in order to improve vegetable production. Groundnut shell which is known as an agricultural waste has not been explored to see if it could serve any use to the agriculture industry. The aim of this study was to evaluate the potential of milled groundnut shell as a nutrient source on the nutritional quality of pepper fruits, and the nutrient uptake by pepper plants in comparison with other nutrient sources. Five treatments were used in this experiment, namely: control, poultry manure, milled groundnut shell, milled groundnut shell in combination with poultry manure and NPK 15:15:15. Proximate analysis was carried out on the pepper fruits from each treatment to check the nutritional composition and tissue analysis was carried out on the pepper stems from each treatment to check the nutrient uptake by the plant. Post- planting soil analysis was also carried out to determine the nutrient residue in the soil. The results from each analysis was subject to data analysis using Statistical Analysis System (SAS) and the means separated using Duncan Multiple Range Test at 5% level of probability. The results from the proximate analysis showed that pepper fruits treated with Poultry manure had higher nutritional composition followed by pepper fruits treated with poultry manure + groundnut shell. The lowest was observed in fruit from NPK 15:15:15. The results from the tissue analysis showed that the pepper plants treated with poultry manure + groundnut shell had higher nutrient uptake while plants treated with NPK 15:15:15 had the lowest nutrient uptake. The results from the post-planting soil analysis showed that soils treated with milled groundnut shell had higher nutrient residue. While soils treated with NPK 15:15:15 had lower nutrient residue. From this study, it can be concluded that groundnut shell possesses nutritional qualities and it can be considered, as a nutrient source. It is recommended that further research work be conducted on the rate of application of milled groundnut shell as a nutrient source and possibly the addition of organic or inorganic nutrient supplements should be considered.

Keywords: Groundnut shell; Organic fertilizer; Inorganic Fertilizer; tissue analysis; nutrient analysis.

INTRODUCTION

Background of the study

Pepper (*Capsicum* sp) is an economically important crop belonging to the family *Solanaceae.* It originated from South and Central America where it is still under cultivation (Pickersgill, 1997). Peppers are commonly divided into three groups; bell peppers, sweet peppers and hot pepper

(Grubben, 2004). Most popular pepper varieties are seen belonging to one of these categories or as a cross pollination between them.

Groundnut *Arachis hypogaea*, is a nutritious leguminous crop grown mainly for oil and seed worldwide. Groundnut shells are the leftover product obtained after the removal of groundnut seed from its pod (Pham Anh Duc, 2019) which are most times burnt, buried or left to litter the environment resulting in environmental contamination. Groundnut shell contains various bioactive and functional components which are beneficial for mankind; commercially it is used in bio-filter carriers etc. (Pham Anh Duc, 2019). However, little is known about its use as organic fertilizer, it is therefore important to ask if this waste can be converted into a form which can add value to the environment and possibly the economy at large.

Aim of the study

The aim of this study is to determine the potential for the utilization of groundnut shell as a nutrient source in the agricultural industry

Objectives of the study

1. To determine the effect of milled groundnut shell in comparison with other nutrient sources on the fruit quality of pepper, and see it's suitability and as the best alternative in curbing agricultural waste problems and reducing waste management costs.

2. To determine the level of nutrient uptake of the pepper plants in the tissue.

MATERIALS AND METHOD

Description of the study site

The research was carried out at the department of Crop Production screen-house and laboratory, Federal University of Technology Minna, Niger state.

2.2 Treatments and Experimental Design

A local variety of pepper called "Dan-Zaria" were obtained from local market. The experiment consisted of five treatments viz: control, NPK 15:15:15, poultry manure, milled groundnut shell, milled groundnut shell + poultry manure. These were replicated five times and arranged in

Completely Randomized Design (CRD). .

Determination of Nutritional Composition

Proximate analysis was carried out on the fruits of the plant. Five samples were used for the analysis by selecting at random replicates from each treatment. Proximate composition (%) of the samples in terms of moisture, ash, fat, crude protein and fibre content were determined using methods described by (Nwinuka N, 2005).

Tissue Analysis

Tissue analysis was carried out on the stems of the plants to determine the nutrient composition in the stem. Five plants were chosen at random from each treatment and replicate for this analysis. The stems of these plants were used to determine the Nitrogen (N), Potassium (K), Phosphorus (P), Calcium (Ca) and Magnesium (Mg) uptake in the plant tissue.

2.5 Post-planting Soil Analysis

Soil analysis was carried out on the soil used to plant the pepper to determine residue of nutrient composition left in the soil. The soil analyzed was taken from all the pots used to plants, 6 weeks after harvest (I.e, from each treatment and replicate).

Data Analysis

The data collected were subjected to Analysis of Variance (ANOVA) using SAS statistical package. The treatments means were separated using Duncan Multiple Range Test at 5% level of probability.

RESULTS

Tables 1 –3. 3 shows the result for proximate composition of the pepper fruits, tissue analysis on the stem of the pepper plant and post planting soil analysis respectively.

Table 3.1 shows that there was no significant difference in the moisture content (MC), ash, crude fibre and crude protein content of the different treatments. Milled groundnut shell (MGS) had the higher value of MC while poultry manure + milled groundnut shell (PM+MGS) had a lower MC. A significant difference was noted in the fat content of the pepper fruits. Fruits from PM are observed having higher fat content, while the lowest was observed in MGS

TABLE 1: Proximate Analysis on Pepper fruits as Affected by Different Nutrient Sources

Treatment	MC%	ASH%	FAT%	CF%	CP%
Control (T1)	3.08^{a}	2.29^{a}	1.46^{cd}	8.05^{a}	5.83^{a}
PM (T2)	3.29^{a}	2.49^{a}	4.00^{a}	7.23^{a}	6.16^{a}
MGS (T3)	3.37^{a}	2.37^{a}	1.03^{d}	7.88^{a}	5.32^{a}
PM + MGS (T4)	2.29^{a}	1.59^{a}	2.90^{b}	8.10^{a}	5.69^{a}
NPK :15:15:15 (T5)	2.46^{a}	2.04^{a}	2.13^{bc}	7.93^{a}	5.83^{a}
SE ±	0.42	0.26	0.32	0.90	0.37

Means with the same letter(s) in the column are not significantly different at 5% level of probability.

PM- poultry manure, MGS- milled groundnut shell, PM + MGS- poultry manure + groundnut shell, NPK- Nitrogen, Phosphorus and Potassium, SE- standard error. MC- moisture content, CF- crude fibre, CP- crude protein.

In Table 2 the stem nutrient compositions of K and Ca were significantly influenced by the applied treatments. While, TON and P were significantly improved by control, PM, MGS and PM + MGS compared to NPK: 15:15:15

Table 2: Tissue Analysis carried out on the stem of Pepper Plant, as Affected by Different Nutrient Source.

Treatment	TON	K	P	Ca	Mg
Control (T1)	1.15^{ab}	268.80^{a}	112.40^{ab}	189.20^{ab}	111.20^{a}
PM (T2)	1.39^{ab}	269.00^{a}	122.60^{ab}	136.80^{ab}	94.00^{a}
MGS (T3)	1.35^{ab}	260.60^{a}	134.80^{a}	180.60^{ab}	105.40^{a}
PM + MGS (T4)	1.61^{a}	303.60^{a}	137.40^{a}	212.20^{a}	117.40^{a}
NPK :15:15:15 (T5)	0.95^{b}	192.80^{a}	84.00^{b}	116.80^{a}	50.80^{b}
SE ±	0.17	35.58	15.48	23.79	10.24

Means with the same letter(s) in the column are not significantly different at 5% level of probability.

PM- poultry manure, MGS- milled groundnut shell, PM + MGS- poultry manure + groundnut shell, NPK- Nitrogen, Phosphorus and Potassium, SE- standard error. TON- total nitrogen, K- potassium, P- phosphorus, Ca- calcium, Mg- magnesium.

In Table 3, the soil's pH level was significant in Control, Poultry Manure (PM), MGS and PM+ MGS. Although the highest value was recorded at control but there was no significant difference between them. The lowest value was observed in NPK: 15:15:15 treated soil.

The soil's Electrical Conductivity (EC) and Exchangeable Cation (Exc) parameter increased in MGS and PM respectively while a decrease of these parameters was observed in NPK: 15:15:15. The Ca content of the soil was higher in control but lower in NPK 15:15:15.

The OC and OM contents of the soil were improved by MGS and PM + MGS, although the highest values were observed in NPK 15:15:15.

The highest TN content in the soil was determined with the application of PM +MGS. However, there was no significant difference between all of the treatments. Soil treated with MGS had the highest Na content. It is also observed that the application of NPK 15:15:15 to the soil, only exerted significant effects on the concentration of Mg and PO4

Table 3: Post-planting Soil Analysis as Affected by Different nutrient Sources

Treatment	Ph	EC	Ca	Mg	OC	OM	TN	Na	K	PO4	Exc cat
Control (T1)	7.25^{a}	253.20^{b}	3.52^{a}	0.69^{a}	0.87^{b}	1.53^{b}	0.58^{a}	1.37^{b}	0.29^{a}	10.54^{a}	0.02^{a}
PM (T2)	7.07^{a}	271.20^{b}	2.44^{bc}	1.53^{a}	0.93^{b}	1.60^{b}	0.18^{a}	0.67^{b}	0.29^{a}	11.16^{a}	0.03^{a}
MGS (T3)	6.97^{a}	363.60^{a}	2.82^{ab}	1.44^{a}	1.34^{a}	2.31^{a}	0.20^{a}	3.29^{a}	0.39^{a}	8.27^{a}	0.02^{a}
PM + MGS (T4)	7.03^{a}	242.00^{b}	1.80^{cd}	2.51^{a}	1.36^{a}	2.35^{a}	0.21^{a}	0.66^{b}	0.22^{a}	12.85^{a}	0.02^{a}
NPK :15:15:15 (T5)	4.29^{b}	112.20^{c}	1.30^{d}	36.92^{a}	0.59^{b}	1.02^{b}	0.13^{a}	0.60^{b}	0.21^{a}	16.00^{a}	0.01^{a}
SE ±	0.78	30.58	0.29	15.99	0.13	0.22	0.16	0.45	0.07	3.35	0.00

PM- poultry manure, MGS- milled groundnut shell, PM + MGS- poultry manure + groundnut shell, NPK- Nitrogen, Phosphorus and Potassium, SE- standard error. Ec - electrical conductivity, Ca- calcium, Mg- magnesium, OC- organic carbon, OM- organic matter, TN- total nitrogen, Na- sodium, K- potassium, PO4- phosphorus, Exc.- Exchangeable cations.

DISCUSSION

In this study we observed that an optimum amount of organic manure is advantageous for higher nutritional content. The results from this research indicates that there was significant amount of ash from all the treatments however, the application of PM gave a higher composition of ash in the peppers. The ash content is an indication of the level of minerals present in the peppers. Consumption of foods rich in minerals helps the human body in maintaining water balance as well as play some useful role in the bone and body (Akintola *et al., 2015)*. The mineral elements present (Ca, P, Mg, Na etc.) in ash were analyzed in the stems of the plants; PM + MGS had the highest composition.

From the proximate analysis, it is noted that pepper fruits from plants treated with PM contained higher fat content. According to (Akintola *et al.,* 2015), fat content in the food is important because it's serves as means of storage and transport of metabolic fuel in the human body. It also serves as electrical insulators for subcutaneous tissues and emulsifier for drug preparations. The results clearly shows that all the treatments supplied rich amounts of crude fibre to the peppers with the highest composition coming from plants treated with PM + MGS. Fibre is considered an essential nutrient for humans because of its role in lowering constipation, diabetes and high blood pressure as well as reduces the risks of developing cardiovascular disease and cancer (Akintola *et al.,* 2015). There was a significant amount of crude protein in pepper fruits from all the treatments, with plants from PM treatment having a higher concentration than the others. Protein have amino acid as its building blocks and it is the only macronutrient in food that contains nitrogen.

The results revealed that the moisture content of the peppers from all the treatments are low with NPK 15:15:15 having the lowest moisture content. Generally, the moisture content of food gives an indication of its susceptibility to microbial spoilage (Effiong *et al*., 2018). The low moisture content of the peppers from the treatments in this study suggests that they are not easily degraded by microorganisms thereby extending the shelf life of the fruits.

According to Botir (2018), organically amended soil is generally reflected in the enhanced nutrient content of the plant vegetative parts. The results from the proximate, tissue and soil analysis from this study agrees with the above statement. In this study, it shows that an increment in the fruit nutrient values were in response to the improved soil quality by the input of poultry manure and Milled groundnut shell to the soil as a nutrient source to pepper. These results show that incorporating organic manure in the soil improves the growth and nutrient attributes of the plants.

Conclusion

This research has shown that milled groundnut shell which is considered an agricultural waste possesses nutritional quality and can serve as a nutrient source in the fertilization of pepper. The milled groundnut shell on pepper exhibited a significant response in the nutritional composition of pepper. Among the five (5) treatments, milled groundnut shell, poultry manure and the combination of poultry manure and milled groundnut shell (PM+ MGS) were observed to have significant impact on the proximate composition of the pepper fruits, nutritional status of the pepper stems lastly, the soil's nutritional composition as compared to NPK:15:15:15.

Recommendation.

Based on this research, it is observed that the addition of milled groundnut shell as a nutrient source could improve the nutritional value in foods. Although the use of milled groundnut shell as a nutrient source has not yet been fully exploited, therefore the following recommendations are suggested;

- Different application rates of milled groundnut shell should be considered for further research.
- Nutrient supplements either organic or inorganic should be added to milled groundnut shell for further research.

References

Akintola O O Bodede A L, Ogunbanjo O R. Nutrional and medicinal importance of Tetrapleura tetraptera fruits (Adrian). [Journal] // J. Sci. Research. - [s.l.] : Afri.J. Sci. Research, 2015. - pp. 33-38.

Botir Khaitov Hye Jin Yun, Yejin Lee, Farrukh Ruziev, Thi Hien Le, Mirjalol Umurzokov, Aung Bo Bo, Kwang Cho, Kee Woong Park Impact of organic manure on growth, nutrient content and yield of chili pepper under various temperature environment [Journal] // Int. J. Environ. Res. Public Health . - 2019.

Effiong B.N., Udofia U. S., Maduka N Studies on Nutritional Composition and Efficacy of Selected Spices in Southern Nigeria against Some Food Spoilage Fungi [Journal] // Journal of Advances in Microbiology . - 2018. - p. 9.

Gradawa M.M Characterisation of Physio-Chemical Properties of Arachis Hypogeal L. Shells (Groundnut) as Environmental Remidation [Conference] // Int'l Conference on Chemical Biological, and Environmental Sciences (ICCBES'14). - Kuala Lumpur (Malaysia) : [s.n.], 2014. - pp. 1-4.

Grubben G. J., & El Tahir, I. M. Capsicum annuum L. In: Grubben, G. J. H., and Denton O.A. (Eds.). PROTA 2: Vegetables/ Legumes. [CD-Rom]. [Journal] // PROTA, Wageningen. The Netherlands.. - 2004.

Nwinuka N, I. G. (2005). Proximate Composition and Levels of Some Toxicants in Four Commonly Consumed Spices. *J. Appl. Sci. Environ. Mgt.*, 150-155.

Pham Anh Duc P. Dharanipriya, Bharath Kumar Velmurugan Groundnut shell - a beneficial bio-waste [Journal] // Bicatalysis and Agricultural Biotechnology. - 2019. - p. 1.

Pickersgill B. Genetic resources and breeding of Capsicum spp. [Journal] // Euphytica 96:. - 1997. - pp. 129- 133.

102 REACTION OF RICE VARIETIES TO RICE BLAST - AN INSIGHT INTO UNDERSTANDING OF RICE RESILIENCE TO CLIMATE INDUCED RICE DISEASES

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Abstract

This study is aimed at identifying the reaction in rice (Oryza sativa L.) varieties to loss in yield due to blast which is a climate induced rice disease. The experiment was carried out at hydromorphic fields of National Cereals Research Institute Badeggi, Southern Guinea Savanna of Nigeria in 2016. The treatments comprised of Ten rice varieties arranged in a randomized complete block design with three replicates. Data were collected on morpho-agronomic traits, 100 grain weight, harvested stool count, number of lesions, and diseases progression. Data collected were subjected to analysis of variance using general linear model procedure of SAS 2008. Results of disease progression showed that FARO 19 and ART16-16-11-25-1-B-1-B-11 had lowest disease progression rate. The results showed no significant differences in grain yield. However, the grain yield showed a range of 4242kgha^{-1} – 1212kgha^{-1}. FARO 19 and ART16-16-11-25-1-B-1-B-11 reactions to blast infestation showed that, they could be used to manage blast in endemic areas. It was concluded that all the varieties of rice can be cultivated with substantial level of yield production based on different levels of control measures. The study showed that differences in climatic environment, morpho-agronomic traits and plant nutrients content particularly silicon, phosphorus and nitrogen confer mechanism of resistance in rice varieties to blast disease infection.

Keywords: Reaction, Rice Blast, Resilience, Diseases, Climate

INTRODUCTION

Rice is the world's most important food cereal crop and a main food source for more than a third of the world's population (Gana *et al.,* 2013). It is grown on 11 % of the world's cultivated land (Dogara *et al*., 2014). There is hardly any country in the world where rice is not utilized in one form or the other. It is one of the few food items whose consumption has no cultural, religious, ethnic or geographical boundary (Isa *et al.,* 2013).

Rice pests are any organisms or microbes with the potential to reduce the yield or value of rice crop. Rice pests include weeds, pathogens, insects, rodents and birds. A variety of factors can contribute to pest outbreaks, including the over use of pesticides and high rate of nitrogen fertilizer application (Jahn *et al*., 2005). Climatic condition also contributes to pests outbreaks. Rice gall midge and army worm outbreak tend to follow high rainfall in the wet season, while thrips outbreak is associated with drought (Douanghoupha *et al*., 2006). Rice diseases include rice ragged stunt, sheath blight, tungro and blast.

Developing disease resistant varieties is the best approach to crop management of rice. The two major diseases that affect rice production are rice blast and sheath blight (Otto, 2015). Outbreaks of these diseases have always proven to be disastrous (NCRI, 2002). Disease control by materials with low environmental effects is most desired (El-Kazzaz *et al*., 2015).

The use of chemical fungicides to control disease has longed been viewed as a last resort for disease management (Hajime, 2001). The use of seed treatment to prevent infection of seedlings after germination and use of fungicide to prevent infection of leaves and panicles during the growing season only attempt to reduce the incidence of blast disease on rice (Gohel and Chauhan, 2015). The objectives of the study was to evaluate the reaction of rice to blast disease and identify rice cultivars with slow blast disease progression rate in relation to the climate.

MATERIALS AND METHODS

This research work was carried out on the hydromorphic rice fields of National Cereals Research Institute (NCRI) Badeggi, Nigeria. Surface soil (0-15 cm) sample was collected from the hydromorphic field of NCRI Badeggi, using a hand trowel. The sample was air dried, gently crushed, passed through a 2 mm sieve and thoroughly mixed together to analyze for the physical and chemical properties.A sample of the soil was further passed through a 0.5 mm sieve to determine the total nitrogen using the micro kjehdal method.

Treatments and Experimental design

The Ten varieties (FARO 52, NERICA 7, FARO 16, FARO 19, ART16-16-11-25-1-B-1-B-11, FARO 49, ART16-9-29-12-1-1-B-1, NERICA 4, ART16-9-6-21-1-2-2-B-B-1 and FARO 38)of rice used for the experiment were collected from NCRI Badeggi due to their reactions to blast. . The treatments are the ten rice varieties which are arranged in a randomized complete block design with three replications.

Procedure

The pathogens collected were isolated from lesions on infected rice leaves in the central laboratory of NCRI, Badeggi using conidial isolation technique (Singh *et al*., 2000). The infected leaves were washed in sterile distilled water before cutting into pieces of 3 cm long. The cuttings were then surface-sterilised in 1 % mercury chloride for 15 seconds, then washed three times with sterile distilled water. They were then plated on moist sterilized filter papers placed in 9 cm petri dishes and treated with 3-5 mls of antibacterial (tetracycline) to avoid bacterial contamination and incubated at 29^{0}C for 24 hours.

Blast scoring was determined using WARDA, (1999) visual disease evaluation scale of 0, 1, 3, 5, 7, and 9, to determine the degree of infection on each variety. This was done at 1, 2, 3, 4, 5, and 6 weeks after inoculation (WAI) for leaf blast, and at 3 weeks after heading for panicle blast.

Disease incidence was determined based on the number of plants leaves infected, lesions and sizes of lesion on the leaves, neck and panicle infected based on WARDA, 2009protocols. This was used to calculate disease progression, (Vander Plank, 1963).

$$r = \frac{1}{t_2} - \ t_1 Log\frac{X_2(1-X_1)}{X_1(1-X_2)}$$

Where: r= rate of disease incidence

t_1= period of first assessment in days

t_2= period of second assessment in days

X_1= initial amount of disease

X_2= amount of disease at second assessment

The results were expressed as percentages increase of the initial values$(\frac{X}{A}x100)$.

Where A is the initial value and X is the difference between the initial and second value.

Other Data taken includes:

Morpho-Agronomic Traits: The data taken are; emergence percentage, days to 50% flowering, leaf area, plant height, tiller count, days to maturity, panicle number and panicle length.

Grain Yield: Data taken are; biomass weight, weight of panicle, harvested stool count, weight before winnowing, grain weight.

Plant Sampling: Rice leaves were sampled on each plot. The plant samples were oven dried at 60^{o}C for three days and milled. The total nitrogen, total phosphorus and silicon concentrations were determined using standard methods as outlined by (Agbenin, 1995).

Data Analysis

Data collected were subjected to Analysis of Variance (ANOVA) using General Linear Model (GLM) procedure of SAS (SAS, 2008). Means were separated using Duncan Multiple Range Test at 5 % level of probability where treatment means shows significant difference. Pearson correlation was used to determine the relationships between the mineral nutrients in the leaves of the rice varieties and level of blast disease infestation on the rice varieties.

RESULTS

Table 1 revealed that there was no significant difference between the varieties nutrient composition. Result of tiller count revealed that FARO 19 had the highest tiller count with significant difference to ART 16-16-11-25-1-B-1-B-11 but was not significantly different from other varieties. Number of days to maturity varied from 123 days (NERICA 4) to 128 days (ART16-16-11-25-1-B-1-B-11, FARO 38 and FARO 52).

Table 1: Mineral nutrients of the leaves

VARIETY	NC (gkg^{-1})	PC ($mgkg^{-1}$)	ABSC (gkg^{-1})	SC (gkg^{-1})
FARO 52	0.9^{a}	23.0^{a}	0.03^{ab}	10.3^{ab}
NERICA 7	1.0^{a}	22.2^{a}	0.03^{ab}	7.9^{ab}
FARO 16	0.94^{a}	23.2^{a}	0.03^{ab}	9.6^{ab}
FARO 19	0.9^{a}	24.5^{a}	0.017^{b}	5.6^{ab}
ART 16-16-11-25-1-B-1-B-11	0.92^{a}	23.1^{a}	0.03^{ab}	11.7^{ab}
FARO 49	0.9^{a}	23.3^{a}	0.03^{ab}	7.0^{ab}
ART16-9-29-12-1-1-1-B-1	0.94^{a}	23.3^{a}	0.04^{a}	13.2^{a}
NERICA 4	1.0^{a}	23.0^{a}	0.03^{ab}	8.73^{ab}
ART 16-9-6-21-1-2-2-B-B-1	0.93^{a}	23.1^{a}	0.04^{a}	8.9^{ab}
FARO 38	0.9^{a}	23.8^{a}	0.023^{ab}	11.2^{ab}
Mean	0.93	23.25	0.03	9.413
±SE	0.038	0.591	0.007	2.284
p-value	0.9284	0.6158	0.5439	0.5933

Values are presented in mean of four replicates. Values with the same superscript alphabets within the column are not significantly different at (p = 0.05) by Duncan Multiple Range Test. KEY: NC: Nitrogen content, PC: Phosphorus content, ABSC: Absorbed silicon, SC: Silicon content.

For days to maturity in Table 2, ART 16-16-11-25-1-B-1-B-11, was significantly different from all other varieties. FARO 52 gave the highest panicle number (16) while NERICA 4 had the lowest Panicle number (6.2). FARO 52 was significantly different (p = 0.05) from all varieties except

ART 16-9-6-21-1-2-2-B-B-1. For panicle blast, FARO 19 had the highest panicle length of 22.9cm while FARO16 had the lowest panicle length of 16.8cm. FARO 19 was significantly different from FARO 16 and ART 16-9-29-12-1-1-1-B-1.

Table 2: Morpho-agronomic traits of rice varieties

VARIETY	EP (%)	D50%F(days)	LA(cm^2)	PH(cm)	TC	DTM(days)	PN	PL(cm)
FARO 52	71.5^{ab}	70.3^{cde}	33.6^{cd}	51.9^{def}	14.7^{abc}	125.0^{bc}	16.0^{a}	19.5^{ab}
NERICA 7	49.1^{ab}	72.7^{bcd}	47.2^{bdc}	80.6^{ab}	14.3^{abc}	125.0^{bc}	9.2^{bc}	22.8^{a}
FARO 16	38.8^{ab}	77.3^{ab}	33.7^{cd}	55.2^{cdef}	15.9^{abc}	124.0^{bc}	10.3^{bc}	16.8^{b}
FARO 19	49.7^{ab}	77.0^{abc}	38.7^{cd}	84.7^{a}	14.0^{abc}	124^{bc}	9.6^{bc}	22.9^{a}
ART 16-16-11-25-1-B-1-B-11	86.1^{a}	66.0^{ef}	54.8^{abc}	63.2^{bcde}	15.8^{abc}	128.0^{a}	8.7^{bc}	19.5^{ab}
FARO 49	74.6^{ab}	77.7^{ab}	28.2^{d}	$60cd^{ef}$	15.4^{abc}	124.7^{bc}	8.7^{bc}	18.2^{ab}
ART 16-9-29-12-1-1-1-B-1	68.9^{ab}	75.0^{abc}	42.1^{bcd}	42.3ef	14.9^{abc}	125.3^{bc}	9.2^{bc}	17.3^{b}
NERICA 4	42.4^{b}	82.0^{a}	52.3^{abc}	69.4^{abcd}	10.3^{c}	123.0^{c}	6.2^{bc}	19.5^{ab}
ART 16-9-6-21-1-2-2-B-B-1	75.2^{ab}	77.0^{abc}	54.6^{abc}	52.7^{dcef}	16.8^{ab}	124.3^{bc}	11.7^{ab}	18.8^{ab}
FARO 38	77.0^{ab}	75.7^{abc}	33.3^{cd}	42.7^{ef}	13.9^{abc}	125.0^{bc}	6.3^{bc}	19.5^{ab}
Mean	63.330	75.070	41.850	60.270	14.600	124.830	9.590	19.480
±SE	16.664	4.452	9.843	14.479	1.768	1.307	2.794	2.021
p-value	0.2629	0.0001	0.0019	0.3957	0.1702	0.0018	0.0724	0.3647

Values are presented in mean of three replicates. Values with the same superscript alphabets within the column are not significantly different at ($p = 0.05$) by Duncan Multiple Range Test. KEY: EP: Emergence percentage, D50%F: Days to 50 % flowering, LA: Leaf area, PH: Plant height, TC: Tiller count, DTM: Days to maturity, PN: Panicle number, PL: Panicle length.

Result of yield parameters are presented in Table 3. Harvested stool count ranged from 47.3 (ART 16-16-11-25-1-B-1-B-11) to 23.7 (NERICA 7) There was no significant difference among the varieties apart from NERICA 7 which was significantly different from ART 16-16-11-25-1-B-1-B-11. The result of the biomass weight revealed that FARO 49 had the highest biomass weight (379g) while FARO 16 (122g) had the lowest biomass weight. In respect to weight of rice before winnowing, NERICA 7 recorded highest (169g) while FARO 16 was the least (70g). NERICA 7 recorded the highest (11.7g) panicle weight while NERICA 4 recorded the least panicle weight of (5g).

Table 3: Grain yield and its components traits for the ten rice varieties

VARIETY	HSC	BW(g)	WRBW(g)	W5P(g)	100GW(g)	GYH(kgha^{-1})
FARO 52	39.3^{ab}	326.3^{abc}	114.3^{ab}	9.7^{abc}	6.7^{a}	1212.0^{a}
NERICA 7	23.7^{b}	294.0^{abc}	169.0^{ab}	11.7^{a}	13.3^{a}	2424.0^{a}
FARO 16	29.0^{ab}	122.7^{c}	70.0^{b}	8.7^{abcde}	20.0^{a}	2424.0^{a}
FARO 19	38.7^{ab}	303.0^{abc}	72.0^{b}	8.3^{abcde}	16.7^{a}	3030.0^{a}
ART 16-16-11-25-1-B-1-B-11	47.3^{a}	315.0^{abc}	131.7^{ab}	8.7^{abcde}	20.0^{a}	3636.0^{a}
FARO 49	45.7^{ab}	379.3^{abc}	117.0^{ab}	7.3^{cde}	13.3^{a}	2424.0^{a}
ART16-9-29-12-1-1-1-B-1	39.0^{ab}	283.3^{abcs}	102.0^{ab}	9.7^{abcd}	23.4^{a}	4242.0^{a}
NERICA 4	26.7^{ab}	150.7^{bc}	153.7^{ab}	5.0^{e}	16.7^{a}	4242.0^{a}
ART 16-9-6-21-1-2-2-B-B-1	41.3^{ab}	325.7^{abc}	114.0^{b}	8.3^{abcde}	16.7^{a}	3030.0^{a}
FARO 38	42.3^{ab}	261.7^{abc}	83.0^{ab}	8.7^{abcde}	26.7^{a}	3030.0^{a}
Mean	37.300	275.378	112.670	8.610	17.350	2969.400
±SE	8.073	84.887	32.848	1.728	5.633	923.474
p-value	0.1794	0.0971	0.4603	0.0395	0.6635	0.66

Values are presented in mean of three replicates. Values with the same superscript alphabets within the column are not significantly different at (p = 0.05) by Duncan Multiple Range Test. KEY: HSC: Harvested stool count, BW: Biomass weight, WRBW: Weight of rice before winnowing, W5P: Weight of five panicles, 100GW: 100gram weight, GYH: Grain yield per hectare.

NERICA 7 was not significantly different from most varieties but was significantly different from NERICA 4 and FARO 52. 100 seed weight ranged from 6.7g to 26.7g. FARO 52 had the lowest 100 seed weight while FARO 38 recorded the highest 100 seed weight. There was no significant difference among the varieties. The seed yield per hectare had no significant difference among the varieties. The result in Table 4 shows that there was a significant difference among the varieties with respect to number of lesions. FARO 52 (9.1) had the highest while FARO 16 (3.9) gave the lowest. FARO 52 was significantly different from FARO 16 but showed no significant difference from other varieties. The disease progression varied significantly from 60.3 (NERICA 7) to 6.5 (ART 16-16-11-25-1-B-1-B-11). NERICA 7 was significantly different from most varieties but was not significantly different from FARO 16 and NERICA 4. Leaf blast ranged from 3.0 - 4.3. There was no significant difference (p = 0.05) among the rice varieties to leaf blast. Result of panicle blast showed that ART 16-9-29-12-1-1-B-1 was most affected (8.3). It was only significantly different from FARO 52.

Table 4: Reaction of rice varieties to blast disease

VARIETY	NL	DPGN	LB	PB
FARO 52	9.1^{a}	15.7^{fgh}	3.0^{a}	4.3^{b}
NERICA 7	7.2^{ab}	60.3^{a}	3.0^{a}	6.3^{ab}
FARO 16	3.9^{bc}	49.1^{abc}	3.7^{a}	7.7^{a}
FARO 19	4.8^{abc}	9.1^{gh}	3.7^{a}	7.7^{a}
ART 16-16-11-25-1-B-1-B-11	5.9^{abc}	6.5^{h}	3.0^{a}	7.0^{ab}
FARO 49	7.6^{ab}	18.7^{efgh}	3.7^{a}	7.7^{a}
ART16-9-29-12-1-1-1-B-1	8.0^{ab}	26.9^{defgh}	3.0^{a}	8.3^{a}
NERICA 4	5.2^{abc}	52.0^{ab}	3.0^{a}	7.0^{ab}
ART 16-9-6-21-1-2-2-B-B-1	7.2^{abc}	33.2^{bcdef}	3.0^{a}	7.7^{a}
FARO 38	8.0^{ab}	26.9^{defgh}	4.3^{a}	7.7^{a}
Mean	6.43	32.66	3.43	7.13
±SE	1.46	6.39	1.38	0.92
p-value	0.2838	0.0001	0.9999	0.4512

Values are presented in mean of three replicates. Values with the same superscript alphabets within the column are not significantly different at (p = 0.05) by Duncan Multiple Range Test. KEY: NL:

Number of lesions, DPGN: Disease progression, LB: Leaf blast, PB: Panicle blast but was not significantly different from other varieties.

Correlation Analysis

Result of correlation coefficient in Table 5 showed that all parameters were not significantly correlated with blast infestation except for number of lesions and nitrogen content (r = 0.4*). Similarly, there was no significant correlation among the plant nutrients except for silicon and phosphorus content with negative but significant correlation and phosphorus and nitrogen content which showed the strongest relationship (r = 0.8**).

Table 5: Correlation analysis

	NL	DP	LB	PB	NC	PC	ABS	SC
NL	1	-0.309^{ns}	0.029^{ns}	-0.26^{ns}	0.384*	0.289^{ns}	0.269^{ns}	-0.23^{ns}
DP		1	-0.003^{ns}	-0.05^{ns}	0.042^{ns}	0.210^{ns}	-0.14^{ns}	-0.38^{ns}
LB			1	0.365^{ns}	-0.01^{ns}	-0.125^{ns}	-0.08^{ns}	0.132^{ns}
PB				1	-0.20^{ns}	-0.199^{ns}	0.167^{ns}	0.138^{ns}
NC					1	0.768**	0.312^{ns}	-0.27^{ns}
PC						1	0.189^{ns}	-0.511*
ABS							1	0.066^{ns}
SC								1

KEY: ^{ns}: Not significant, *: Significant, **: Very significant, NL: Number of lesions, DP: Disease progression, LB: Leaf blast, PB: Panicle blast, NC: Nitrogen content, PC: Phosphorus content, ABS: Absorbed silicon content, SC: Silicon content.

Discussion

This paper showed that blast disease greatly affects the agronomic traits of the rice varieties, which leads to variations in plant height, leaf area, tiller number, panicle length, panicle number, biomass weight, and grain yield. The results however, showed that leaf and panicle blast had no effect on the grain yield. This agrees with the findings of Koutroubas *et al.*, (2015), Who reported that inoculation of rice varieties with blast isolates affected immensely the overall agronomic traits of rice but had negative correlation to grain yield. At low humidity, varieties with high above average grain yield were characterized with average height, late flowering, wider leaves, fewer tillers, higher above ground biomass, late maturity and there was higher silicon and phosphorus content in their leaves. This corroborates with the report of Vange and Obi (2006), who reported that agronomic traits and cultural practice affects blast disease effects on seed yield. Similarly, varieties with low yield under the effect of high rainfall had; tiny leaves flowered earlier, more tillers, average height, reached maturity earlier and high rate of disease progression, which supports the works of Ishihara *et al.* (2014) who states that there is no significant difference between panicle and leaf blast under high humidity. Tiller count had significant variation which could be as a result of phosphorus level in the varieties. This supports the report of Alan *et al.* (2009) statement that tiller productions were highly responsive to phosphorus levels.

Experimental result showed that, some varieties (FARO 38, ART 16-9-6-21-1-2-2-B-B-1 and ART 16-9-29-12-1-1-1-B-1) had average rate of disease progression, high level of leaf silicon and nitrogen content and above average nitrogen content. This could be a reflection of late maturing, wide leaves, fewer tillers, average height and delayed maturing qualities they possessed, which is in line with the report of Huang *et al.* (2010), who reported that phenotypic variance is an evidence of resistance to rice climatic induced blast disease. From the experimental results all the varieties did not show any significant difference in respect to leaf and panicle blast, they however varied in terms of disease progression and seed yield with relations to the climate of the environment and silicon, phosphorus and nitrogen contents in the plant. This is similar with the works of Ashraf *et al.* (2017), which states that mechanism of resistance to blast is influenced by the climate of the environment and mineral nutrients of the plant. The result of the nutrient correlation of this research suggests that phosphorus uptake by rice plant tissue is a major determinant in the ability of its ability to resist blast infestations in relation to its individual early crop maturity aided by nitrogen uptake. Similarly, silicon positively aids rice resistance to blast at lower concentration of nitrogen (Mayamulla *et al.*, 2017), in line with this, the research also suggests that higher levels of silicon aids the regulation of nitrogen uptake in plant tissues which help to reduce the number of lesions, hence prevents blast infestation.

The experiment showed that grain yield showed no variation among the varieties with relations to the climatic condition. This could be as a result of the varietal yield potential differences and nutrient content level of the varieties in consent to the reports of Smith *et al.* (2012) who reported that grain yield showed no significant differences with respect to good management practices under high humid conditions. Similarly, effect of climate change on nutrients of the rice varieties is suggested to be a measure of the resistance mechanism in the rice varieties (Ashraf, *et al.*, 2017).

Conclusion

It was concluded that two varieties; NERICA 4 and ART16-9-29-12-1-1-1-B-1, gave the best reaction to blast infection under the Badeggi Hydromorphic climate conditions. Also, two varieties expressed slow disease progression rate effectively; FARO 19 and ART16-16-11-25-1-B-1-B-11. With the result of this study all the varieties of rice can be cultivated with substantial level of yield production based on different levels of control measures. The study showed that differences in climatic environment, morpho-agronomic traits and plant nutrients content particularly silicon, phosphorus and nitrogen confer mechanism of resistance in rice varieties to blast disease infection.

REFERENCES

Agbenin, J. O. (1995). Laboratory Manual for Soil and Plant Analysis. (Selected Method and Data Analysis). Published by the author. 140pp

Alan, M. M., Hasanuzzaman, M. & Nahar K. (2009). The dynamics of three irrigated rice varieties under varying phosphorus level. *American-Eurasian Journal of Agronomy*. 2(2), 88-94.

Ashraf M. A., Mohammed M. M., Ahammad A. J. S., & Mohammad N, M. (2017). Computational study of silicon transporter protein in rice and wheat. *International Journal of Computational Bioinformatics and In Silico Modeling*, 2(4), 199-205.

Dogara, A. M., & Jumare, A. I. (2014). Origin, distribution and heading date in cultivatedrice. *International Journal of Plant Biology and Research,* 2, 1008-1014.

Douangboupha, B. K., Khamphoukeo, K., Inthavang, S., Schiller J., & Jahn G. (2006). *Pest and Diseases of the Rice Production Systems of Laos,* 265-281.

El-kazzaz, M. K., Salem, E. A., Ghoneim, K. E., Elsharkawy, M. M., El-Kot, G. A. N., Kalboush, Z. A. E. (2015). Integrated control of rice kernel smut disease using plant extracts and salicylic acid. *Archives of Phytopathology and Plant Protection*. DOI: 10.1080/03235408.2015.1092202.

Gana, A. S., Shaba, S. Z., & Tsado, E. K. (2013). Principal component analysis of Morphological traits in thirty-nine accessions of rice *Oryza sativa* L. grown in a rainfed lowland ecology of Nigeria. *Journal of Plant Breeding and Crop Science,* 5(x), 120-126

Gohel, N. M., & Chauhan, H. L. (2015) Integrated management of leaf and neck blast disease of rice caused by *Pyricularia oryzae. African Journal of Agricultural Research*, 10(19), 2038-2040.

Hajime, K. (2001) *Pesticide outlook*. Japan Crop Protection Association-Chome Muromachi, Nihonbashi, Chuo-Ku, Tokyo 103, Japan, 1, 5- 8

Huang X., Xinghua W., Tao S., Qiang Z., Qi F., Yan Z., Canyang L., Chuanrang Z., Tingting L., Zhiwu Z., Meng L., Danlin F., Yunli G., Ahong W., Lu W., Liuwei D., Wenjun L., Yiqi L., Qijun W., Kunyan L., Tao H., Taoying Z., Yufeng J., Wei L. & Zhang L. (2010). Genome-wide association studies of 14 agronomic traits in rice landraces. *Journal of nature Genetics,* 4(2), 961-967

Isa, J. O., Cyprian, C. A., & Sam, O. O. (2013). Resource use efficiency and rice production in Guma Local Government Area of Benue State: An application of stochastic frontier production function. *International Review of Social Sciences and Humanities*, 3(1), 108-116

Ishihara T., Yuriko H, Shinichi O, Kaworu E, Nghia T, Keiko H, Taketo A, Fumihiko S & Shinzo K. (2014). Quantitative trait locus analysis of resistance to panicle blast in the rice cultivar Miyazakimochi. Journal of biomedical science 7(2) DOI: 10.1186/s12284-014-0002-9

Jahn, G. C., Almazan, L. P., & Pacia, J. (2005). Effects of nitrogen fertilizer on the intrinsic rate of increase of the rusty plum aphid, *Hysteroneura setariae* (Thomas) (Homoptera: Aohididae) on rice (*Oryza sativa L*). *Environmental Entomology*, .34(4), 938-943

Khush, G. S. (1997). Origin, dispersal, cultivation and variation of rice. *Plant Molecular Biology*, 35, 25–34

Koutroubas, S. D., Katsantonis, D., Ntanos, D. A., & Elisabetta, L. (2015). The effect of Blast disease on rice growth, yield and quality in the field. *Turkish Journal of Agriculture and Forestry*. 33 (5), 487-494.

Mayamulla, S., Weerarathne, L. V. Y., Maramba, B., Sirisena, D. N., & Suriyagoda, L. D. B. (2017). Variation in seed nutrient content, seedlings growth, and yield varieties of rice varieties grown in paddy field without application of fertilizers for forty years. *Journal of Crop and Pasture Science*. 68 (4), 337-348.

Otto M. (2015). Integrated pest management for rice production in Nigeria report on a consultancy for the *Competitive Africa Rice Initiative Programm*e Abuja, Nigeria. Retrieved from https://www.growafrica.com/competitive/

Smith, J., Fukai, S., & Mitchell, J., (2012). Rice grain yield-a comparison between direct seeding and transplanting in Lao People Democratic Republic. *The Regional Institute online publishing*. Retrieved from http://www.dpi.nsw.gov.au

Vange T. & Obi I. U. (2006). Effect of planting date on some agronomic traits and grain

Yield of upland rice varieties at Makurdi, Benue state, Nigeria· *Journal of Sustaianable Development in Agriculture and Environment 2, 86 – 92.*

103 ALLELOPATHIC EFFECT OF MINTWEED (*Hyptis suaveolens (L.*) Poit) GREEN AND BROWN LEAVES AQUEOUS EXTRACT ON SEED GERMINATION AND SEEDLING GROWTH OF COWPEA

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Abstract

Hyptis suaveolens is an invasive weed that has negative effects on native plant communities and impedes the growth of vulnerable or threatened species growing near it. This study revealed the allelopathic effect of the aqueous extract of the green and brown leaves of *Hyptis suaveolens* on seed germination and seedling growth of cowpea at different concentration (0 %, 2.5 %, 5 %, 7.5 % and 10 %) in a laboratory – based experiment. The treatments were arranged as a 2 x 5 factorial in a Completely Randomized Design (CRD) in four replications. Results revealed that irrespective of the leaf type, there was no significant difference in the allelopathic potential on the seed germination and seedling growth of cowpea. In contrast, the concentration of the extracts had a significant allelopathic effect on cowpea seed germination and seedling growth, such that the inhibition was concentration dependent. The inhibition of the seed germination and seedling growth increased with the increase in the concentration from 0 to 10 %. The highest concentration (10%) of *H. suaveolens* leaf extract significantly reduced the germination percentage, germination index, mean germination time, radicle and plumule lengths by 61.5 %, 63.9 %, 61.7 %, 54.2 % and 62.5 %, respectively. It was apparent that the 10% concentration had more inhibitory (-61.5%) effect on the germination and seedling growth of cowpea relative to the control. This weed must therefore be controlled in the cowpea field at their initial growth.
Keywords: Allelopathy, Germination, Seedling growth, Concentration and Cowpea

INTRODUCTION

Hyptis suaveolens (L.) Poit, which is commonly known as Mintweed, is an important invader of the tropical and sub-tropical regions of the world (Afreen *et al.*, 2017). *Hyptis* possesses several characteristics common to other invasive species, such as allelochemicals that help in its survival and spread. This species has wide ecological amplitude, high plasticity and reproductive capacity because it is able to grow on a variety of soil types, land uses and land cover type (Padalia *et al.*, 2013). *Hyptis* possesses faster growth rate, massive seed production, high proliferation rate, dual mode of reproduction (from perennating root-stocks as well as seed). Higher resistance against pathogens due to allelochemicals and essential oil (Raizada, 2006).

The growth and establishment of other plant species near the clumps of *H.suaveolens* is quite restricted (Raizada *et al*., 2006) but the specific reasons that lead to the dominance of *H. suaveolens* still remain unclear. One of the plausible reasons for such interference could be due to the presence of allelochemicals in this plant. Allelochemical activities of aqueous methanol extract of *H. suaveolens* on the germination and seedling growth of several weeds and crop species have been reported by Momimul-Islam *et al.* (2013) and Daniya *et al.* (2014).

Allelopathy refers to the effect of one plant species on another through the release of chemical compounds known as allelochemicals into the environment (Weih *et al*., 2008), which may either be promoting (synergistic) or inhibiting (antagonistic) depending on the compounds released and target plants. The potential use of allelopathy as a natural means for weed suppression in Agro ecosystems has attracted the interest of researchers for a long time (Yongqing *et al.*, 2014).

Cowpea (*Vigna unguiculata* (L.) Walp) is an important pulse crop widely cultivated in the tropics. The pods are highly nutritive and are a good source of digestible protein, dietary fiber and vitamin A and C. In addition to these the pods also contain Ca, P, Na, K, Mg, Fe, Zn, Mn and Cu (Gerrano *et al*., 2017). However, it is sensitive to weed competition especially at the early stage of crop development and the period from 14 to 40 days after sowing (DAS) has been considered critical for the weed competition (Osipitan *et al.*, 2016). Weed infestation has been reported to be more severe during the rainy season and causes severe yield reduction (Gupta *et al.*, 2016). The impact of weed interference on cowpea yield depends on the duration and stage at which the crop-weed interference takes place. The season-long competition has resulted in 53 to 76 percent yield reduction in cowpea (Gupta *et al.*, 2016).

The aim of the study was to assess the allelopathic effect of aqueous extracts of green and brown leaves of *H. suaveolens* at varying concentrations on germination and seedling growth of cowpea.

MATERIALS AND METHODS

A set of experiments was carried out to assess the allelopathic effect of *H. suaveolens* on germination and seedling growth of cowpea in a laboratory at Department of Crop Production, Federal University of Technology, Minna, Niger State. Green and Brown leaves of *H. suaveolens* were collected at flowering stage from farmlands within the Federal University of Technology Gidan Kwano Campus, Minna, Niger State during the rainy season of 2022. The two leaves were separated, air dried under the shade for four weeks and later oven dried at 70°C to a constant weight. The powder of each plant part was soaked in distilled water for 24 hours in a ratio of 1:20 (w/v) at room temperature. The water extracts of each plant part were filtered through a Whatman No. 1 filter paper to obtain the pure aqueous extracts without impurities. The extracts prepared in this manner were used as stock solutions with concentration of 10 % (w/v), and further dilutions to 2.5 % (w/v) of extracts of green and brown leaves of *H. suaveolens* were made by adding distilled water to the stock solution for carrying out the experiment at varying concentrations: - 0%, 2.5% (1:40 w/v), 5% (1:20 w/v), 7.5% (1: 15 w/v) and 10% (1: 10 w/v) against cowpea in a laboratory condition. Ten cowpea seeds were placed on a filter paper in 9 cm diameter petri dishes, separately. In each petri dish, 10 ml of green or brown leave aqueous extracts at 2.5%, 5%, 7.5% and 10% and distilled water was poured as per the treatments. Distilled water was used as control for comparison. The temperature during the growing period of cowpea ranged from 29.0 to 31.8°c. The experiment was observed for 16 days. Petri dishes were kept moistened during the whole period of study. The number of seeds germinated was counted on a daily basis. Germination percentage, germination index, mean germination time and germination energy were determined using the formulae shown below: -

(a) Germination percentage (GP)

GP= $\frac{Germinated\ seeds}{Total\ seeds}$ x 100 as described by the Association of Official Seed Analysts (AOSA, 1990).

(b) Mean germination time (MGT)

MGT=$\frac{\sum Dn}{N}$ Ellis Roberts as described by Safder *et al.* (2021)

Where n = number of germinated/emerged seeds on day `D` and `D` equal days of count

(c) Germination Index (GI)

GI= $\frac{No\ of\ germinated\ seeds}{Days\ of\ first\ count} + \frac{No\ of\ germinated\ seeds}{Days\ of\ first\ count}$ as described by AOSA (1990)

(d) Radicle and Plumule length: This were measured using a centimetre rule.

(e) Percentage Inhibition/Stimulation: -

Inhibition (-) or Stimulation (+) = $\frac{Germinated\ seeds\ in\ extracts}{Germinated\ seeds\ in\ control} - Germinated\ seed\ in\ control$ x 100

The data collected were subjected to the analysis of variance (ANOVA) using the Statistical Analysis System (SAS) software package version 9.0. Differences between the treatments means were separated by the Least Significant Difference (LSD) at 5% level of probability.

RESULTS AND DISCUSSION

Germination Indices of Cowpea

The allelopathic effect of green and brown leaves extracts of *H. suaveolens* on germination indices of cowpea are hown in Table 1. The germination percentage, germination index and mean germination time was not significantly affected by either green or brown leaves of *H. suaveolens* (Table 1). In contrast, the germination indices were significantly reduced by the concentrations of the aqueous extract of the leaves (Table 1). Furthermore, the germination percentage, germination index and mean germination time were significantly reduced as the concentration of the extract was increased from 0 % to 10 %. The highest concentration of 10 % consistently and significantly reduced the germination percentage, germination index and mean germination time compared to the control. The allelopathic inhibition of germination in cowpea could be attributed to the presence of allelochemicals at varying concentrations in the water extracts of the *H. suaveolens* leaves. Oraon and Mondal (2021) demonstrated that *H. suaveolens* inhibited the seed germination, though in rice. Furthermore, Oraon and Mondal (2021) substantiated that allelopathic activity depends on the concentration and varies from species to species.

Seedling Growth of Cowpea

The allelopathic effect of extracts of *H. suaveolens* on seedling growth of cowpea is shown in Table 2. The radicle and plumule lengths were not significantly affected by either green or brown leaves of *H. suaveolens*. In contrast, the radicle and plumule length were significantly reduced by the concentrations of the aqueous extract of the *H. suaveolens* (Table 2). Both radicle and plumule lengths were significantly reduced as the concentration of the extract was increased from 0 % to 10 %. Maximum reduction in radicle and plumule lengths were recorded with the highest concentration (10 %) in this study. Increasing the concentrations of aqueous leaf extracts increased the inhibitory effect of the radicle and plumule lengths of cowpea. Oraon and Mondal (2021) also reported that the germination and seedling growth of several crops are affected by the allelopathic influence of *H. suaveolens.*

Table 1: Allelopathic effect of water extract of green and brown leaves of *Hyptis suaveolens* at varying concentration on germination indices of cowpea

Treatment	Germination Percentage	Germination Index	Mean Germination Time
Leaf type (L)			
Green	54.0a	2.4a	5.4a
Brown	63.0a	2.7a	6.3a
LSD (0.05)	11.6	0.5	1.2
Concentration(C) (%)			
0	81.3a	3.6a	8.1a
2.5	70.0ab	3.1ab	7.0ab
5.0	58.8bc	2.6bc	5.9bc
7.5	51.3c	2.2cd	5.1c
10	31.3d	1.3d	3.1d
LSD (0.05)	18.3	0.8	1.8
Interaction			
L x C	NS	NS	NS

Means with different letters from each other differ significantly at $p \leq 0.05$: NS = Not significant.

Table 2: Allelopathic effect of water extract of green and brown leaves of *Hyptis suaveolens* at varying concentration on radicle length, plumule length, stimulation and inhibition of cowpea

Treatment	Radicle length (cm)	Plumule length (cm)	Stimulation and inhibition (%)
Leaf (L)			
Green	2.8a	6.7a	-28.8a
Brown	3.1a	7.6a	-25.6a
LSD (0.05)	0.5	1.0	16.0
Concentration (C)			
0	3.5a	9.6a	0.0a
2.5	3.5a	8.0b	-12.7ab
5.0	3.0a	7.3b	-26.6b
7.5	3.0a	7.0b	-35.2b
10	1.6b	3.6c	-61.5c
LSD (0.05)	0.8	1.5	25.27
Interaction			
L x C	NS	NS	NS

Means with different letters from each other differ significantly at $p \leq 0.05$: NS = Not significant: negative values represent inhibition

CONCLUSION

It can be concluded in this study that irrespective of the type of leaves of *H. suaveolens*, the aqueous extract of the leaves had a strong allelopathic potential to fully inhibit the germination and seedling growth of cowpea. The 10 % concentration of aqueous extract of the *H. suaveolens* leaves strongly inhibited the germination and seedling growth of cowpea.

REFERENCES

Afreen, T., Srivastava, P., Singh, H. & Singh, J. S. (2017). Effect of invasion by *Hyptis suaveolens* on plant diversity and selected soil properties of a constructed tropical grassland, *Journal of Plant Ecology* 5, 751-760.

Association of Official Seed Analyst (AOSA). (1990). Rules for testing seeds. *Journal of Seed Technology*, 12, 1 – 112.

Daniya, E., Ibrahim, H. & Abdullahi, F. (2014). Allelopathic potential of mint weed (*Hyptis suaveolens* Poit.) on germination behaviour of some okra (*Abelmoschus esculentus* (L.) Moench) varieties; *Journal of Applied Agricultural Research* 6(11), 245-251.

Gerrano, A.S., Van Rensberg, W.S.J & Adebola, P. (2017). Nutritional composition of immature pods in selected cowpea (*Vigna unguiculata* (L.) Walp) genotypes in South Africa. *Australian Journal of Crop Science* 11 (02), 134-141.

Gupta, K. C., Gupta, A. K. & Saxena, R. (2016). Weed management in cowpea (*Vigna unguiculata* (L.) Walp.) under rainfed conditions. *International Journal of Agricultural Science* 12 (2), 238-240.

Mominul-Islam, A. K. M. & Kato-Noguchi, H. (2013). “Plant growth inhibitory activity of medicinal plant *Hyptis suaveolens*: could allelopathy be a cause?” *Emirates Journal of Food and Agriculture*, 25(9), 692–701.

Oraon, S. & Mondal, S. (2021). Allelopathic effect of lamiaceae weeds on seed germination and early growth of aromatic rice (*Oryza sativa*). *Acta Agrobotanica* 74, article 741.

Osipitan, O. A., Adigun, J. A & Kolawole, R. O. (2016). Row spacing determines critical period of weed control in crop: Cowpea (*Vigna unguiculata*) as a case study. *Azarian Journal of Agriculture* 3 (5), 90-96.

Padalia, H., Kudrat, M & Sharma K. P. (2013). Mapping sub-pixel occurrence of an alien invasive *Hyptis suaveolens* (L.) Poit. Using spectral unmixing technique. *International Journal of Remote Sensing* 34, 325 – 40.

Safder, V. & Nix, H. A. (2021). Land use and productive potentials enhancing sustainable production. *International Journal of Research in Agriculture and Forestry*, 16, 17 – 21.

Weih, M., Didon, U. M. E., Ronnberg-Wastljung, A. C & Bjorkman C. (2008). Integrated agricultural research and crop breeding: allelopathic weed control in cereals and long-term productivity in perennial biomass crops. *Agricultural System* 97, 99–107.

Yongqing, Ma., Meng, Zhang., Yaolin, Li., Junfeng, Shui & Yeng, Jun Zhou. (2014). Allelopathy of rice (*Oryza sativa*. L.) exudates and its relations with *Orobanche cumana* wallr. and *Oronbanche* minor sm. Germination, *Journal of Plant Interactions 9(1), 722-730.*

104 PROXIMATE COMPOSITION OF SOME NEW SWEET POTATO VARIETES GROWN AT GIDAN KWANO, MINNA, NIGER STATE, NIGERIA

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Abstract

This study investigated the, proximate composition of some new sweet potato varieties grown in Gidan Kwano, Minna, Niger State, Nigeria. Sweet potato is an important security crop in Nigeria because it is less expensive to grow. They are cultivated via their vines. Little studies have really being carried out to identify the chemical composition of these sweet potato varieties - Solo-gold, Mother's delight, purple fleshed sweet potato and a local white fleshed potato. four varieties of sweet potatoes (White fleshed sweet potato (WFSP), Orange fleshed Sweet Potato ($OFSP_1$), Purple fleshed sweet potato (PFSP), and Orange fleshed sweet potato ($OFSP_2$)) were taken as the treatments. The treatments were arranged in a randomized complete block design and replicated three times in the field. The result showed that proximate composition of the fresh and dry samples of the four selected sweet potato varieties was significantly different among the varieties for all the parameters. The study showed that all the tested sweet potato varieties had different levels of proximate and phytochemical contents. However, high contents of moisture, ash, crude fibre, dry matter, beta carotene, phenols and anthocyanin were found in the Purple Fleshed Sweet Potato variety. This variety is therefore recommended for farmers at Gidan Kwano.

Keywords: Sweet potato, Varieties, proximate composition; Total polyphenol content; Total carotenoids content

INTRODUCTION

Sweet potatoes are an important food crop of the tropical and subtropical areas and have nutritional advantage for the rural and urban dwellers of these regions as seen by the increase in its production and consumption (Low *et. al*., 2020; Ettah *et. al*., (2022).

Sweet potato is cultivated mainly because of its tuberous roots that are sweet and tasty. It has a long and tapered structure and its smooth internal colour can be varied from deep orange, yellow, purple, violet, beige and white, depending on its varieties (Mu and Singh, 2019). Sweet potato varieties may vary in terms of their nutritional compositions such as carbohydrates, lipids, proteins, vitamins, dietary fibres, and other bioactive compounds including anthocyanin and beta-carotene.

Phytochemicals can be found in both the leaves and roots of sweet potato plants containing antioxidants, anti-inflammatory, anti mutagenic, antimicrobial and anti carcinogenics which all promotes health functions in humans (Ginting, and Yulifianti, 2015; Buzo, et., al., 2016 and Wang, et., al., 2016). The phytochemical composition varies according to the different flesh colour of sweet potato.

There is little information available on the chemical composition of sweet potato varieties. such as - *Mother's delight*, *Solo-Gold*, Purple Fleshed Sweet Potato - PFSP and local White Fleshed Sweet Potato WFSP widely grown in Nigeria. Sweet potato varieties and to identifying the proximate composition, (mineral composition and photochemical analysis) of *Solo gold, Mother's delight*, purple fleshed sweet potato - PFSP and a local white fleshed sweet potato varieties especially in the study area.

The objective of this study was to compare the selected nutritional content/composition of four varieties of sweet potatoes cultivated in Minna, Nigeria.

These are *Mother's delight*, *Solo gold*, Purple fleshed sweet potato - PFSP and a local white variety found in Minna, Niger state, Nigeria.

MATERIALS AND METHODS

Experimental Site

The experiment was carried out under rain fed conditions from July – October in 2021 at the Horticultural farm, Federal University of Technology Gidan Kwano, Minna, Niger state, Nigeria.

Source of Planting Material

The vines of the sweet potato varieties were sourced from the Naeson Ventures of the Federal University of Agriculture, Makurdi and local farmers for their local sweet potato.

The sweet potato varieties used in this study were *Solo gold*; Orange fleshed sweet potato ($OFSP_1$) *Mother delight;* ($OFSP_2$) Purple fleshed sweet fleshed sweet potato (PFSP) - and the White fleshed sweet potato (WFSP) – local variety, as the control.

Treatment and Experimental Design

Four varieties of sweet potatoes (White fleshed sweet potato (WFSP), Orange fleshed Sweet Potato ($OFSP_1$), Purple fleshed sweet potato (PFSP), and Orange fleshed sweet potato ($OFSP_2$)) were taken as treatments. The treatments were arranged in a randomized complete block design and replicated three times in the field. The plot size used was 4m × 3m (12-m^2).

Proximate Analysis

The moisture content, ash content, crude fibre and dry matter of the sweet potatoes' varieties were determined as described by the Association of Official Analytical Chemists (A.O.A.C., 2010).

Determination of Moisture Content

Moisture was determined by oven drying method. Two grams of each of the samples was taken into crucible was accurately weighed in clean, dried crucibles (W_1). The crucibles were allowed into an oven at 100-105^{0}C for 6-12 h until a constant weight was obtained. Then the crucibles were then placed in the desiccators for 30 min to cool. After cooling, they were then weighed again (W_2). Per cent moisture content was determined using the formular below:

$$\%\ Moisture\ content\ \frac{W1-wW2}{Weight\ of\ sample} \text{x } 100$$

Where

W = Initial weight of crucible + Sample 1

W = Final weight of crucible + Sample 2

Determination of Ash Content

For the determination of ash, clean empty crucibles were then placed in a muffle furnace at 550^{0}C for an hour, cooled in desiccators and then weight of empty crucible was noted (W_1). Two grams of each of sample was taken into crucibles (W_2) and was purchased over a burner, until it was charred. Then the crucible was placed in muffle furnace for ashing at 550^{0}C for 2-4 h. the appearance for grey white-ash indicates complete oxidation of all organic matter in the sample. After ashing the crucibles were then cooled and weighed (W_3). The per cent ash was calculated by adopting the formular below:

$$\%\ \text{Ash} = \frac{\text{Difference in Weight of Ash x 100 equation}}{\text{Weight of Sample}}$$

$$\text{Difference in weight of ash} = W_3 - W_1$$

Determination of Crude Fibre

Two grams (2g) of samples were defatted with per ether; boiled under reflux for 30min with 200ml a solution containing 1.25g of H_2SO_4 per 100ml of solution (Edeoga *et al.*, 2005). The solution was filtered through linen or several layers of cheese cloth on fluted funnel, washed with boiling water until the washings are no longer acidic then the residue was transferred into a beaker and boiled for 30 min with 200 ml of solution containing 1.25 g of carbonate free NaOH per 100 ml, the final residue was filtered through a thin but close pad of washed and ignited asbestos in a Gooch crucible, then dried in an electric oven and weighed after which it was incinerated, cooled and reweighed. The loss in weight after incineration x 100 is the percentage crude fibre.

Determination of Dry Matter

100 grams of the representative sample was weighed and placed in an oven that was set at 25^{0}F. This was allowed to stay in the oven at the set temperature for 30 minutes. The weight of the dry sample was recorded and from this, the dry matter (DM) content was calculated by using the equation shown below as described by Association of Official Analytical Chemists (AOAC, 2010).

$$\% \text{ Dry Matter (DM)} = \frac{\text{Final Dry Weight (grams)}}{\text{Initial Wet Weight (grams) X 100}}$$

Phytochemical Analysis

Total Phenol

Three grams of the samples were defatted with 100ml of diethyl other using a Soxhlet apparatus for 2hr. the fat free sample was boiled with 50ml of petroleum ether for the extraction of the phenolic component for 15min (Edeoga *et al.*, 2005). Five (5 ml) of the extract was pipetted into a 50 ml flask, then 10 ml of distilled water was added. Also, 2 ml of ammonium hydroxide solution and 5ml of concentrated amyl alcohol were also added. The samples were made up to mark and left to react for 30min for colour development. This was measured at 505nm. Tannic acid was used to establish the calibration curve.

Anthocyanin

Anthocyanin was determined according to Killet (1994) Method. 0.2g of potato samples were homogenized with 3 ml 1 HCL-methanol (99:1), the extract were centrifuged at 18000 g for 30 min at 4℃, the supernatant were left overnight in dark place at 5℃. Anthocyanin content were measured at 550 nm using spectrophotometer.

Beta-carotene

The Beta-carotene determination was carried out using the method of the Association of Official Analytical Chemists (AOAC, 2010). A conical flask containing 50 ml of 95% ethanol, 10 g of the macerated sample was placed and maintained at a temperature of 70-80^{o}C in a water bath for 20 minutes with periodic shaking. The supernatant was decanted, allowed to cool and its volume was measured by means of a measuring cylinder and recorded as initial volume. The ethanol concentration of the mixture was brought to 85% by adding 15 ml of distilled water and it was further cooled in a container of ice water for about 5 minutes. The mixture was transferred in to a separating funnel and 25 ml of petroleum ether (pet-ether) was added and the cooled ethanol was poured over it. The funnel was swirled gently to obtain a homogenous mixture and it was later allowed to stand until two separate layers were obtained. The bottom layer was run off into a beaker while the top layer was collected in to a 250 ml conical flask. The bottom layer was transferred in to the funnel and re-extracted with 10ml pet-ether for 5-6 times until the extract became fairly yellow. The entire pet-ether was collected in to 250 ml conical flask and transferred in to separating funnel for re-extraction with 50ml of 80% ethanol. The final extract was measured and poured into sample bottles for further analysis. The absorbance of the extracts was measured using a spectrophotometer at a wavelength of 436 nm. The concentration of β-carotene was calculated using Bear-Lamberts Law, which states that the absorbance (A) is proportional to the concentration (C) of the pigment, as represented by the equation:

$A \propto L$ (if concentration (C) is constant). $A=ECL$; $C=A/EL$

Where: C= concentration of carotene

A= absorbance

E=extinction coefficient

L= thickness of cuvettes (path length) =1cm

E of β-carotene =1.25x104 µg/l

Data Analysis

The data collected were subjected to analysis of variance (ANOVA) using statistical analysis system (SAS) 2013 package version 9.0. Treatment means were compared using the least significant difference (LSD) at $P \leq 0.05$.

Results

Proximate composition

The proximate composition of the fresh and dry samples of the four selected sweet potato varieties was significantly different among the varieties (Table 1). Moisture content was significantly different among the potato varieties in both samples. The Purple Fleshed Sweet Potato produced the highest moisture content (68.40 % and 48.26 %) in the fresh and dry samples respectively compared to the White Fleshed Sweet Potato which had the least moisture content (54.67 % and 37.52 %) for the fresh and dry samples, respectively.

In terms of the ash content of the fresh and dry samples of the sweet potato varieties the Purple Fleshed Sweet Potato variety also produced significantly higher ash content (2.03) than the other sweet potato varieties. The White Fleshed Sweet Potato variety had the lowest ash content (0.18 what unit for the fresh samples and 0.28 what unit for the dry samples).

The crude fibre content of the fresh and dry samples of sweet potato varieties showed that Purple Fleshed Sweet Potato had the highest values of 1.06 and 1.04, respectively, which was in turn similar with the fresh Yellow Fleshed Sweet Potato. Irrespective of the treatments/samples, the White Fleshed Sweet Potato consistently had the lowest crude fibre content.

Regarding the dry matter content, the Purple Fleshed Sweet Potato produced significantly heavier dry matter (48.52 for the fresh sample and 41.53 for the dry sample) compared to the other sweet potato varieties. Inversely, the Orange Fleshed Sweet Potato consistently produced the least dry matter by in both fresh and dry samples, respectively.

Phytochemical composition

The beta carotene, phenol and anthocyanin contents of fresh and dry samples of four sweet potato varieties is shown in Table 2. The fresh and dry samples of Purple and Yellow Flesh Sweet Potato varieties produced significantly higher Beta carotene contents by 4.49 and 4.50 than the other sweet potato varieties. In contrast, the White Fleshed Sweet Potato (fresh sample) and Orange Flesh Sweet Potato (dry sample) produced the lowest Beta carotene content by 1.03 and 2.34, respectively in this study.

Furthermore, the phenol content of the fresh and dry Purple Fleshed Sweet Potato was significantly higher by 53.54 and 55.40, compared with the other varieties. The fresh White Fleshed Sweet Potato and dry Yellow Fleshed Sweet Potato produced the lowest phenol contents by 26.60 and 23.19, respectively.

The anthocyanin content of some fresh and dry sweet potato varieties differed significantly in this study. Irrespective of the sweet potato sample, the Purple Flesh Sweet Potato variety produced significantly higher anthocyanin content by 131.56 and 133.04 than all the other sweet potato varieties. The White Fleshed Sweet Potato variety consistently produced the lowest anthocyanin content in both fresh and dry conditions by 94.23 and 94.01, respectively.

Table 1: Proximate analysis of fresh and dry Sweet potato varieties for moisture, ash, crude fibre and dry matter contents

	Moisture content		Ash Content		Crude fibre Content		Dry matter Content	
Potato variety	Fresh	Dry	Fresh	Dry	Fresh	Dry	Fresh	Dry
Control - WFSP	54.67c	37.52d	0.18d	0.28d	0.44c	0.33d	30.78c	25.25c
Orange - $OFSP_1$	55.01c	42.30c	0.47c	0.84c	0.74b	0.53c	28.29d	23.13d
Purple - PFSP	68.40a	48.26a	1.42a	2.03a	1.06a	2.03a	48.52a	41.53a
Orange - $OFSP_2$	62.59b	46.74b	0.82b	0.92b	1.04a	0.92b	33.56b	30.02b
LSD (0.05)	0.77	0.17	0.22	0.03	0.07	0.11	0.39	0.22

Means with the same letter(s) under the same column are not significantly different from each other at P≤ 0.05 by LSD.

Table2: Proximate analysis of Beta carotene, phenols and anthocyanin contents of Some fresh and dry potato varieties

	Beta carotene Content		Phenols Content		Anthocyanin Content	
Potato variety	Fresh	Dry	Fresh	Dry	Fresh	Dry
Control - WFSP	1.03c	2.71c	26.60d	32.63c	94.23d	94.01d
Orange - $OFSP_1$	1.55b	2.34d	26.03c	39.07b	117.54c	111.61c
Purple - PFSP	4.49a	4.80b	53.54a	55.40a	131.56a	133.04a
Orange – $OFSP_2$	4.50a	5.02a	37.34b	23.19d	123.20b	120.48b
LSD (0.05)	0.05	0.02	0.07	0.03	1.75	0.02

Means with the same letter(s) under the same column are not significantly different from each other at P≤ 0.05 by LSD.

Discussion

Generally, there was variation in proximate and phytochemical composition in sweet potato varieties evaluated in this study. This might be attributed to the genetic diversity that exist within the sweet potato genotypes. The high content of moisture, ash, crude fibre, dry matter, beta carotene, phenol and anthocyanin in the Purple Fleshed Sweet Potato is an indication of its superior genetic characteristics in production of proximate and phytochemical constituents of sweet potato. Although, the moisture content in this variety was high, this suggests the poor storability quality associated with this variety. Furthermore, in our study, the Yellow Fleshed Sweet Potato produced high content of crude fibre, and beta carotene which might be an expression of its genetic inheritance in the production of this components.

CONCLUSION

It can be concluded from this study that all the tested sweet potato varieties had different levels of proximate and phytochemical contents. High contents of moisture, ash, crude fibre, dry matter, beta carotene, phenols and anthocyanin were found in the Purple Fleshed Sweet Potato variety. For the production of healthy food, the Purple Fleshed Sweet Potato variety is hereby recommended.

REFERENCES

A.O.A.C., 2010. Official Methods of Analysis. 16th Edn. Association of Official Analytical Chemist. Washington, DC, USA.

Buzo, H., Mon gi, R. J., and Mukisa, I. M. (2016). Development and assessment of nutritional quality and sensory properties of orange fleshed sweet potato and bambara groundnut based snacks for school children. RUFORUM Working Document Series No. 14 (2) : 1067 - 1073. Available from http://repository.ruforum.org.

Edeoga H. O; Okwu,D. E and Mbaeble B.O.(2005). Phytochemical constituents of some Nigerian medicinal plants. Afr. J. Biotechnology 4(7) 685-688.

Ettah, Otu I., Udumo, Bassey O., Abanyam, Victor A. And Bullem Francis A. (2022). Resource use in sweet potato production in delta state, nigeria: a technical efficiency approach. Global Journal of Agricultural Sciences Vol. 21, 2022: 1-6. https://dx.doi.org/10.4314/gjass.v21i

.Ginting, E. and Yulifianti, R. (2015). Characteristics of noodle prepared from orange-fleshed sweet potato and domestic wheat flour. Procedia Food Science 3: 289 – 302.

Killet, U. (1994). Vitamin retention in extrusion cooking. Journal of Food Chemistry, 49: 149-155.

Low, J. W., Oritz,R,. Vandamme, E., Andrade, M., Biazin, B, and Gruneberg, W. J., (2020). Nutrient-dense orange fleshed sweet potato: Advances in drought-tolerance breeding and understanding of management practices for sustainable next-generation cropping systems in sub-Saharan Africa. Frontiers in Sustainable Food Systems 4:50. doi: 10,3389/fsufs.2020.00050.

Mu, T., Sun, H., Zhang, M. and Wang, C. (Eds.) (2017). Sweet potato processing technology. USA: Academic Press. https://doi.org/10.1016/C2015-0- 04259-9.

Wang, S., Nie, S, Zhu, F. 2016. Chemical constituents and health effects of sweet potato. Food Research International 89: 90–116

105 EVALUATION OF SACCHARUM *OFFICINARUM* GENOTYPES FOR JUICE QUALITY, CANE AND SUGAR YIELD

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Abstract

The evaluation of sugarcane genotypes on juice quality, cane and sugar yield were investigated at Badeggi, Nigeria in 2015 and 2016. The genotypes were planted in a Randomized Complete Block Design (RCBD) and replicated three times. Data were collected om germination and establishment at 21 and 42 DAP respectively, tiller count at 2 MAP, stalk girth, number of stools per plot, number of millable cane per plot, brix and cane yield per plot at 12 MAP. Data collected were subjected to analysis of variance (ANOVA) and means were separated using least significant difference. The result indicated significant differentiation among genotypes. The results revealed that genotypes ILS 708-05 was characterized by high potential cane yield (105.54 t/ha). BD 1576-14 significantly had higher brix content (24.90%) among the tested genotypes. The genotypes BD1354-17, BD-135420 and BD1388-31 had high cane and sugar yields and were higher in estimated recovery sucrose (ERS). These genotypes can be selected for more evaluation under different ecologies. Genotypes (BD1576-31, BD1576-07, BD1576-14, and ILS708-2) that have better sucrose/cane yield can be maintained and used as parents in germplasm for further improvements.

Keywords: Genotypes, Juice quality, Sugarcane, Sugar, Cane yield

Introduction:

Sugarcane (*Saccharum officinarum* L.) is a leading cash crop that accounts for over 60 % of the sugar required in the world and the remnant 40 % being contributed by sugar beet (Sulaiman *et al*. 2015). It is widely grown in several tropical and subtropical countries of the world. The goal of sugarcane breeding programme is to increase sugar yield by increasing sugar production per unit area. According to Mohammed *et al*. (2019), sugarcane production can only be improved through the adoption of promising varieties and technologies. Increased cane yield is a function of higher genetic potential of the variety. The production of sugarcane seedlings from genetically diverse parents or breeding clones is essential for developing high sugar yield, disease and insect resistant cultivars and weed suppressive ability, for industrial production or by local chewing cane farmers (Katia *et al*., 2019). Increasing sugar content in sugarcane crop is closely associated with height, diameter and number of the stalks, along with sugar accumulation in the stalk as reported by Katia *et al*. (2012) and Mohammed *et al*. (2019). Oni (2016) reported that sugar industries in Nigeria rely more on cultivars brought from overseas rather than those developed in Nigerian Research Institutes, due to inadequate information about the performance of the cultivars that were bred in the country. Assessment of performance, adaptation of different sugarcane genotypes to different environments and evaluation of their traits are necessary before a variety is released for commercial cultivation. Clone selection at pre-commercial stage can help in the identification of improved genotypes for commercial production of sugarcane (Mohammed *et al*., 2019). Therefore, the objective of the study was to evaluate the impact of some exotic hybrid clones to juice quality, cane yields and industrial potentials over the existing varieties.

Materials and Methods

The field trial was conducted at the upland sugarcane experimental field of the National Cereals Research Institute, Badeggi (Lat. 9^{o} 45′ N, Long. 06^{o} 07′ E) in the southern Guinea Savanna of Nigeria in 2015 and 2016 rainy season. The site used in each year had been under continuous sugarcane cropping for over a decade. The total rainfall during the experimental period was 1504.1 mm in 2015 and 1045.4 mm in 2016 while the mean air temperature was 35 to 38^{o}C in 2015 and 34 to 36^{o}C in 2016. Fifteen genotypes (ILS_1576-02, ILS_1576-20, BD_1576-31, BD_1576-07, BD_1354-17, BD_1576-14, ILS_708-05, 1LS_169-06, BD_1354-20, ILS708-02, BD_1388-23, ILS_1260-03, BD_1388-31, BD_1388-33, BD_1388-43) which were hybrids of crosses from Mauritius were raised and evaluated through series of selection processes at the National Cereals Research Institute Badeggi and University of Ilorin Sugar Research Institute. The fifteen clones were promising genotypes selected to advance yield trial in the year 2016. The clones were planted in a Randomized complete block design (RCBD) and B-47419 (a prominent commercial variety) was used as a Check (Standard). Each clone was planted on 5 m x 5 m plot and replicated three times. Each plot was made up of 6 rows with inter row distance of 1 m. Ten setts were planted per row and each sett comprises of three buds. Agricultural practices for sugarcane production were adopted from the recommendations of NCRI Badeggi. Data were collected on germination and establishment at 21 and 42 days after planting (DAP) respectively, tiller count at 4 months after planting (MAP); stalk girth, stalk length, number of stools per plot, number of millabe canes per plot, Brix and cane yield per plot at 12 MAP. Cane juice was analyzed for purity, polarity, sucrose, glucose, fibre and Estimated Recoverable Sucrose percent (ERS). The Estimated Recoverable Sucrose percent (ERS) and smut incidence were analyzed as follows:

Estimated Recoverable Sucrose percent (ERS) ERS (%) = [pol % - (Brix – pol) x NSF] CF.
NSF = Non sugar factor (0.70) and CF = Cane factor 0.57 (Hundito et al., 2009)

All data collected were subjected to analysis of variance (ANOVA). The means were separated using LSD (least significant difference) at 5 % level of probability using SAS version 9.0 statistical package.

Results: The yield parameters for the genotypes at maturity was significant different at 12 months after planting except stalk per stool (Table 1). The genotype ILS 708-02 obtained higher number of cane stools per plot which was significantly the same with B47419 and the least cane stools/plot was recorded in BD 1576-31 genotype. Higher stalk length was observed in ILS 708-02 which was similar to ILS 169-06, BD 1388-33 and BD 1354-20. The genotype, ILS 708-02 had heavier single stalk weight which was not significantly different from BD 1576-31, ILS 708-05, BD 1354-20, BD 1388-23, BD 1388-31 and BD 1388-33. The highest cane yield (105.54 t/ha) was recorded in ILS 708-05 genotype, while ILS 1576-02 genotype had the lowest cane yield (60.22 t/ha) among the other genotypes. Brix content was significantly ($P<0.05$) different between the sugarcane genotypes studied. At ten and twelve months after planting, BD 1576-14 and BD1576-07 genotypes produced the highest brix (23.70 and 24 %, respectively) which was at par with ILS1576-02 (Table 1). The results also revealed that sugar content of some genotypes improves with sugarcane crop age between ten to twelve months. This can sometimes be used to identify maturity period of the sugarcane genotypes. There was a significant difference in juice quality among all the entries (Table 2). BD 1388-33 produced the highest purity of 90.7 % and BD 1576-14 gave the least purity (78.3 %). Maximum polarity (24.26 %) was recorded in ILS 1260-03 and the lowest polarity (19.3%) was observed in BD 1388-43. Also, our result shows that the genotypes studied exhibit differences in estimated recovery sucrose (ERS). Genotypes BD 1388-31(11.1) and ILS 1260- 03(11.0 %) had the highest ERS and the lowest ERS was recorded in BD 1388-43. The genotype BD1388-31 proved superior in term of ERS and cane yield (11.1 and 102.5 ton/ha).

Discussion: The significant variation in stools per plot and stalk length in the study could be attributed to better growth and varied morphology of the genotypes. These findings are in agreement with the result obtained by Muhammad *et al*. (2014), who reported similar assessment of sixteen sugarcane varieties in Pakistan. Maximum stalk girth (2.90 cm) was found in ILS 708-05 genotype, which is comparatively better than the stalk girth (1.93 cm) of the commercial check variety (B47419 The high stalk girth, single stalk weight and cane yield expressed by some genotypes in the study can be attributed to diverse genetic composition of the clones which arose from the wide genetic differences of their parents. Katia *et al*. (2019) reported that higher cane yield is the function of higher genetic potential of a variety. Our findings in this study were similar to the work of other researchers that revealed significant differences in cane yield among some sugarcane genotypes. Muhammad *et al*. (2014), Ahmed *et al*. (2014) and Bassey *et al*. (2019), reported high cane yield of different sugarcane genotypes in their respective studies.The variation among the studied genotypes in brix content could be governed by its superior genetic potential and the uniform expression of genes for these attributes. Our findings in this study agrees with the report of a study carried out in Nigeria by Kwajaffa and Olaoye (2014), which showed significant variation in brix content among 20 genotypes (from 17.8 to 25.0 %). Mohammed *et al.* (2014) also, reported non-significant differences in brix content among some sugarcane varieties, and stated that it may be due to the uniform expression of genes for these attributes. Islam *et al*., 2011 had also reported a similar trend on purity (75.9 % to 89.3 %) and pol (12.0 % to 13.4 %) variations among six sugarcane clones. Our findings are in conformity with the result of Khan *et al.*, (2018), had reported that it is difficult to achieve high cane yield and sugar recovery in the same genotype

Conclusion: The study had shown that genotypes BD1354-17, BD-135420 and BD1388-31 that showed high yielding and estimated recovery sucrose (ERS) can be selected for more evaluation under different ecologies. Those genotypes (BD1576-31, BD1576-07, BD1576-14, and ILS708-2) that have better sucrose/cane yield can be maintained and used as parents in germplasm for further improvements.

Table 1: Evaluation of Sugarcane genotypes on Cane and Yield attributes

Varieties	Stalk per stool 12 MAP	Stool per plot 12 MAP	Stalk girth (cm) 12 MAP	Stalk length (cm) 12 MAP	Single Stalk wt (kg) 12 MAP	Cane yield (t ha^{-1}) 12 MAP	Brix (%) 10 MAP	Brix (%) 12 MAP
B47419	8.7	28.7	1.9	187.2	0.6	89.2	19.3	20.7
ILS 1576-02	9.6	20.0	2.2	152.9	0.5	60.2	20.9	24.07
ILS 1576-20	7.5	26.0	2.2	186.1	0.8	64.2	18.0	21.3
BD 1576-31	7.8	15.0	2.3	174.4	0.9	46.3	20.6	23.9
BD 1576-07	8.6	31.0	2.1	170.4	0.5	84.3	22.0	23.8
BD 1354-17	9.1	32.7	2.2	206.1	0.8	103.4	17.9	19.9
BD 1576-14	7.5	26.0	2.2	179.9	0.7	74.3	23.7	24.9
ILS 708-05	7.5	21.3	2.9	202.7	0.9	105.5	18.7	20.9
ILS 169-06	9.7	27.7	2.1	213.3	0.8	70.1	19.7	22.5
BD 1354-20	8.6	29.7	2.4	211.1	1.0	89.4	17.7	20.9
ILS 708-02	5.3	35.0	2.7	214.9	1.1	80.5	21.2	23.7
BD 1388-23	7.4	28.3	2.3	203.1	0.8	85.6	20.5	20.7
ILS 1260-03	6.0	29.0	2.3	206.5	0.8	77.4	19.9	20.2
BD 1388-31	7.7	32.3	2.4	199.8	1.0	102.5	17.6	19.7
BD 1388-33	7.9	21.7	2.4	212.7	0.9	65.7	17.7	21.0
BD 1388-43	9.5	27.3	2.3	204.1	0.7	83.4	19.2	19.9
LSD (0.05)	2.8	9.0	0.3	13.5	0.3	23.4	2.2	1.6
CV (%)	20.9	20.0	7.9	9.6	21.6	17.5	6.8	4.3

MAP-Months after planting, LSD-Least significant difference, CV- Coefficient of variation

Table 2: Evaluation of Sugarcane genotypes on Juice quality

Varieties	Dry matter	Moisture (%)	Fibre (%)	Purity (%)	Polarity (%)	Sucrose (%)	Glucose (%)	ERS (%)
B47419	37.2	62.8	11.2	85	22.1	24.5	30.7	10.6
ILS 1576-02	35.8	64.2	10.8	85.5	22.1	24.4	30.5	9.0
ILS 1576-20	36.1	63.9	11.1	82.6	20.6	22.7	28.4	7.8
BD 1576-31	37.2	62.8	9.2	84.1	23.5	26.1	32.7	9.9
BD 1576-07	37.0	63.0	13.0	86.6	20.8	22.8	28.6	8.2
BD 1354-17	38.5	61.5	13.5	82.3	20.6	28.3	28.3	8.3
BD 1576-14	34.3	65.7	8.3	78.3	20.4	22.5	28.2	9.1
ILS 708-05	34.3	65.7	9.3	85.0	21.2	23.4	29.3	9.0
ILS 169-06	41.4	58.6	15.0	89.9	22.9	25.6	32.0	9.5
BD 1354-20	32.7	67.3	7.7	87.5	21.9	24.1	30.2	9.6
ILS 708-02	69.3	30.7	45.3	87.1	20.9	23.0	28.7	9.1
BD 1388-23	37.8	62.2	11.2	81.2	21.6	24.0	30.0	8.7
ILS 1260-03	31.9	68.1	3.9	86.6	24.3	27.0	33.7	11.0
BD 1388-31	42.0	58.0	14.0	86.2	24.2	27.1	33.8	11.1
BD 1388-33	35.2	64.8	9.2	90.7	23.6	25.9	32.6	10.5
BD 1388-43	31.2	68.8	8.2	83.9	19.3	21.1	26.4	7.4
LSD (0.05)	6.7	8.1	3.2	9.8	5.8	1.8	2.1	1.4
CV (%)	17.3	8.8	4.5	4.9	5.2	4.7	12.2	4.6

LSD-Least significant difference, CV- Coefficient of variation

References:

Ahmed, M., K. P. Baiyeri, and B. C. Echezona. (2014). Evaluation of organic mulch on the growth and yield of sugarcane in the southern guinea of Nigeria. *The Journal of Animal and Plant Sciences*, 24: 329-335.

Bassey M.S, Daniya E , Odofin A.J. and Kolo M.G.M (2019). Weed species diversity as influenced by sugarcane genotypes, trash mulch and weed management practices at Badeggi, Nigeria. *Proceedings of the 1st Annual Conference of Sugarcane Technologist Society of Nigeria*, Abuja, 1st – 4th July 2019, 11-19.

Hundito, K., T. Negi and B. Mulatu, (2009). Estimation of recoverable sugar in Ethiopia sugar factories. Proceeding of the Ethiopian Sugar Industry Bien Conference, Volume 1, (ESIB'09), *Ethiopian Sugar Industry*, pp: 147-155.

106 IMPACTS OF SUGARCANE GENOTYPES AND WEED MANAGEMENT PRACTICES ON WEED DRY MATTER AND SUGARCANE PRODUCTIVITY

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Abstract

Yield decline is an issue that has plagued sugarcane production in Nigeria. The objective of the study was to evaluate the effects of sugarcane genotypes and weed management practices on weed dry matter and productivity of sugarcane at Badeggi, southern Guinea Savanna of Nigeria. The treatments were two sugarcane genotypes (Bida local and NCS 001) and four weed control measures (weedy check, 5 monthly hoe weeding (5 MHW), pre-emergence (PE) application of diuron at 2 kg a.i ha^{-1} + Post-Emergence (POE) of 3-maize force at 179.2 g ha^{-1} + two hoe weeding (2 HW)] and PE diuron + POE 3-maize force arranged in a split plot design and replicated three times. Weed control measures constitute the main plot while sugarcane genotypes constitute the subplot. The results revealed that PE diuron plus POE 3 – maize force, 5 MHW and PE diuron plus POE 3 – maize force plus 2 MHW produced comparable stalks and brix content. Also, 5 MHW generated taller sugarcane plants. Application of PE diuron plus POE 3 – maize force proved equally effective as 5 MHW contributed the highest cane yield. Lower weed dry matter was found in Bida local, and taller stalks, maximum cane girth, higher brix content and cane yield were observed in NCS 001. In conclusion, application of 5 MHW or PE diuron plus POE 3 – maize force plus 2 MHW or PE diuron plus POE 3 – maize force effectively controlled weeds, increased stalk height, cane girth, brix content and cane yield of sugarcane, especially NCS 001.

Keywords: Genotype; sugarcane; dry matter; weed management, productivity

Introduction

Sugarcane (*Saccharum officinarum* L.) is one of the most important crops in the world. It is cultivated in more than 90 countries around the world and accounts approximately, 75 % of world's sucrose production (Wada *et al.,* 2017). The cultural method of weed control which is manual weeding is a common practice of most cane growers in Nigeria. This practice is labourious, costly and non- effective against perennial weeds like *Cyperus rotundus* particularly in the sugarcane ratoon. Apart from the quantitative damages caused by weeds due to competition for water, light and nutrients, weeds also cause reduction in potential sugar yield as well as a loss of significant quantities of nutrients. Yield decline is an issue that has plagued sugarcane production in Nigeria despite the cultivable land potentials capable of producing over 3.0 million metric tons of sugarcane annually. The acceptance of a variety by most sugarcane growers in Nigeria now depends on its yield potentials in plant and ratoon crop (Priyanka *et al*., 2019). One way to improve the yield of sugarcane, irrespective of the genotypes is by weed control practices. In Nigeria, research information on sugarcane genotypes when sown under different weed control practices is scarce. Hence, the objectives of the study were to evaluate the effects of sugarcane genotypes and application of weed management practices on weed dry matter and sugarcane productivity.

Materials and Methods: A field trial was conducted at the upland sugarcane experimental field of the National Cereals Research Institute, Badeggi (Lat. 9° 45′ N, Long. 06° 07′ E) in the southern Guinea Savanna of Nigeria in 2016 and 2017. Before cultivation, the vegetative cover of the experimental site was manually cleared, ploughed and harrowed with a tractor in the first week of February 2016 and 2017. The land was fully irrigated before planting by pumping water from a stream using a 3.5 HP water pump with a 12.5 cm diameter hose. Thereafter, the land was marked out into plots with bunds at the edges for water retention. Gross plot size was 5 m x 4 m (20 m^2) consisting of 4 sugarcane rows, and net plot size was 5 m x 2 m (10 m^2) consisting of 2 sugarcane rows. Each row was spaced at 1 m apart. Tender healthy young stalks of six months old sugarcane were used as planting material. The stalks were cut into setts each containing three eye buds, planted continuously end-to-end without intra-row spacing in shallow sunken bed. The application of pre-emergence (PE) diuron was done immediately after planting at 2.0 kg a.i ha^{-1}. The application of post-emergence (POE) 3 – maize force at 179.2 g ha^{-1} [metolachlor 375 g L^{-1} plus terbuthylazine 125 g L^{-1} plus mesotrione 37.5 g L^{-1}] was applied at 5 weeks after planting (WAP). The NPK fertilizer was applied at 150 kg N, 60 Kg P_2O_5 and 90 Kg K_2O in equal halves at planting and 10 WAP. Irrigation water was applied at 41.3 L per plot once per week from February to April. Rainfall was supplemented with irrigation in May which was the establishment of the rainy season. The treatments consisted of a factorial combination of two sugarcane genotypes [chewing cane (Bida local) and industrial cane (NCS 001)], and four weed management practices [weedy check, monthly hoe weeding for five months (5 MHW), application of PE diuron + POE 3 – maize force, and application of PE diuron plus POE 3 – maize force + 2 MHW] arranged in a split-plot design and replicated three times. Weed management practices were allocated to the main plot, while sugarcane genotypes were the subplot. Herbicides were applied with knapsack (CP3) sprayer at a spray volume of 4 L ha^{-1} at 206 KPa. Weed species samples in each plot were collected from a 1 x 1 m^2 quadrat at 3, 6 and 9 months after planting (MAP). Weed species seedlings in each quadrat were clipped at the soil level and identified according to Akobundu *et al*. (2016). The weed species were counted to determine the weed density on plot basis and expressed in number per m^2. The weed samples were oven dried at 80^0 C to a constant weight and weighed to determine the dry matter in g per m^2. Stalk height at 12 MAP was taken from the soil level to the tip of the last unfolded leaf using a graduated ruler. Stalk girth (cm) at 10 MAP was taken using Vernier caliper. Percent Brix at harvest (12 MAP) was taken using Hand refractometer to determine the level of soluble sugar. Sugarcane stools per plot was taken by counting the number of stools at 12 MAP. Millable stalk per stool was taken by counting the number of stalks at 12 MAP. Yield (t ha^{-1}) at harvest was taken from the harvested stalks and weighed. All data collected were subjected to analysis of variance (ANOVA). The means were separated using Duncan Multiple Range Test at 5 % level of probability using SAS version 9.0 statistical package.

Results: The results indicated that weed dry weight was significantly lower in Bida local cane than NCS 001 cane at 3 and 9 MAP only (Table 1). The study also showed that weed dry weight was significantly affected by weed management practices such that, application of PE diuron + POE 3 – maize force herbicides at 3 and 6 MAP, PE diuron + POE 3 – maize force herbicides + 2 MHW at 9 MAP in 2016 and PE diuron + POE 3 – maize force herbicides at 9 MAP in 2017 produced the lowest weed dry weight, while no weeding accounted for the highest (0.27 g m^2)(Table 1). Stalk height was significantly ($P<0.05$) different between the sugarcane genotypes in both years of study (Table 2). The industrial sugarcane, NCS 001 was significantly taller than the local chewing cane, Bida local. Furthermore, 5 MHW consistently had taller plants than other weed management practices in both years of study (Table 2). Thicker sugarcanes were recorded in Bida local plots compared with that in NCS 001 plots in both years of study (Table 2). Stalk girth was significantly thicker in plots treated with 5 MHW, but at par with the application of PE diuron + POE 3 – maize force plots in 2017 only (Table 2). Higher Brix content was obtained in NCS 001 sugarcane compared with that from Bida local sugarcane in both years of study (Table 2). Furthermore, 5 MHW and application of PE diuron + POE 3 – maize force herbicides in the two years of study, and PE diuron + POE 3 – maize force herbicides + 2 MHW in 2016 only recorded similar higher Brix content compared to other sugarcane plants given the other weed management practices (Table 2). NCS 001 genotype significantly produced more number of stools than Bida local (Table 2). Number of stools per plot varied significantly with weed management practices. All the treatment with weed control had similar effect on number of stools produced, but greater than that of the weedy check (Table 2). Furthermore, NCS 001 genotype significantly produced more number of millable stalks than Bida local (Table 3). Weed management practices significantly affected number of millable stalks per stools Application of 5 MHW produced bigger millable stalks in 2016 and 2017 plant crops, which were similar to those of other weed control practices. The weedy check consistently produced the lowest millable stalks. Cane yield of sugarcane was significantly higher in NCS 001 plots compared with Bida local in the two years of study (Table 3). Furthermore, Weed management practices significantly influenced sugarcane yield at 12 MAP (Table 4). Application of 5 MHW produced higher cane yield in 2016 plant crop while the cane yield of PE +POE and PE + POE + 2 MHW were at par. On the other hand, application of PE +POE herbicide had the highest cane yield but was at par with PE + POE + 2 MHW in 2017.

Discussion: The superiority of Bida local genotype in reducing weed growth and producing thicker canes than the NCS 001 could be attributed to its morphological characteristics such as leaf canopy formation and its more robust nature which might have shaded weed seed germination and seedling growth. This finding is in agreement with the work of Takim *et al*. (2014) who noted that sugarcane varieties vary in growth characteristics, which can in turn directly affect weed competition. The production of consistently taller sugarcane stalk, higher Brix and cane yield in plots with NCS 001 can be attributed to better crop growth (in terms of internode length and tillering ability) governed by its superior genetic potential and efficient use of applied inputs for improved growth and cane yield. The result agrees with the findings of Kuri and Chandrashekar (2015) who observed significantly taller millable cane, longer internode with sugarcane genotype, CoSnk 07103 than the other genotypes, except Co92005 (G3). The higher cane yield in the study was similar to the work of Mohammed *et al*. (2019) who recorded the highest cane yield with ILS 708-05 genotype compared to other genotypes tested. These authors also stated that high Brix content and cane yield by a sugarcane genotype is a function of the higher genetic potential of the variety. The maximum reduction of weed growth (dry matter) by PE diuron + POE 3 – maize force + 2 MHW and PE diuron + POE 3 – maize force could be attributed to effective desiccation and season-long weed control in sugarcane. This observation corroborates with the findings of Choudhary and Singh (2016) who reported the need to apply pre-emergence and post-emergence herbicides for effective season-long weed control in sugarcane production. Also, the practice of 5 MHW produced taller stalks than all the other weed management practice, thicker canes which were comparable with PE diuron + POE 3 – maize force, higher Brix content which was comparable to PE diuron + POE 3 – maize force + 2 MHW and PE diuron + POE 3 – maize force; which suggest that these treatments provided good weed control and enhanced sugarcane growth and yield. Nadir *et al.* (2015) also observed that weed control treatments decreased weed growth and favourably enhanced yield contributing characters of sugarcane such as stalk height and girth, and Brix content. The higher cane yield from plots which were monthly hoe weeded five times and application of PE diuron + POE 3 – maize force, could be attributed to an effective reduction of weed growth which provided conditions for good crop growth and yield of sugarcane. Choudhary and Singh (2016) also reported that manual hoe weeding and application of PE + POE herbicides can effectively reduce weed growth and increase sugarcane growth and yield.

Conclusion

The study has shown that the application of 5 MHW or PE diuron plus POE 3 – maize force plus 2 MHW or PE diuron plus POE 3 – maize force effectively controlled weeds, increased growth and cane yield of sugarcane, especially NCS 001 in this agroecology of Nigeria.

Table 1: Effects of sugarcane genotypes and weed management practices on weed dry weight at 3, 6 and 9 MAP in 2016 and 2017 seasons

Treatment	Weed dry weight (gm^{-2})					
	3 MAP		6 MAP		9 MAP	
Treatments	2016	2017	2016	2017	2016	2017
Genotypes (S)						
Bida local	0.53	0.55	0.43	0.41	0.24	0.21
NCS 001	0.54	0.61	0.44	0.43	0.26	0.24
LSD (0.05)	0.006	0.003	0.20	0.12	0.76	0.62
Weed management (W)						
Weedy check	0.59	0.64	0.49	0.46	0.32	0.27
5 MHW	0.55	0.59	0.45	0.44	0.25	0.22
PE +POE+ 2 MHW	0.52	0.57	0.42	0.41	0.22	0.23
PE + POE	0.48	0.52	0.38	0.37	0.20	0.18
LSD (0.05)	0.01	0.03	0.02	0.03	0.95	0.73
Interaction						
S x W	NS	NS	NS	NS	NS	NS

LSD- least significant difference, MHW-Monthly hoe weeding, PE- Pre-emergence (Diuron at 2 kg a.i/ha) herbicide, POE- Post-Emergence (3-Maize force at 179.2 g/ha) herbicide, NS-Not significant, MAP- Months after planting

Table 2: Effects of sugarcane genotypes and weed management practices on stalk height, Girth, Brix content, Number of Stool per plot , Millable stalks and Came yield at 12 MAP in 2016 and 2017 seasons

Treatment	Stalk height (cm)		Stalk girth (cm)		Brix content (%)		Number of Stool per plot		Millable stalks per stool		Cane yield (t ha^{-1})	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Genotypes (S)												
Bida local	146.4	172.5	3.05	3.27	16.49	16.74	9.17	17.63	3.01	3.29	52.12	57.24
NCS 001	178.6	201.9	2.63	2.68	18.28	18.29	11.75	22.17	5.51	5.33	82.27	66.18
LSD (0.05)	11.05	33.65	0.12	0.11	0.62	0.58	1.27	1.47	0.52	0.40	4.63	4.61
Weed management (W)												
Weedy check	148.5	168.7	2.37	2.66	16.60	16.30	8.17	14.67	3.63	3.75	57.33	54.91
5 MHW	181.5	209.1	3.15	3.24	18.15	18.38	11.79	20.83	4.63	4.63	77.54	61.29
PE +POE+ 2MHW	161.4	186.0	2.93	2.99	17.11	17.38	10.46	21.88	4.35	4.29	66.08	63.76
PE + POE	158.7	184.9	2.91	3.24	17.68	18.0	11.42	22.21	4.43	4.58	67.81	66.87
LSD (0.05)	15.63	20.03	0.17	0.16	1.29	0.82	1.79	2.09	0.73	0.57	8.36	5.23
Interaction												
S x W	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

References

Akobundu I.O., Ekeleme F., Agyakwa C.W. & Ogazie C.A (2016). *A Hand book of West African Weeds.*IITA, Ibadan- Nigeria. 521pp

Choudhary H.R & Singh R.K (2016). Effect of sequential application of herbicides on weeds and production of spring planted sugarcane (Saccharum officinarum L.). *International Journal of Life Sciences*, 11(1), 687-690

Kuri, S. & Chandrashekar, C.P. (2015). Growth indices and yield of sugarcane genotypes under organic, inorganic and integrated nutrient management practice. *Karnataka Journal of Agricultural Science* 28: 322-326.

Mohammed, A. K., Ishaq M.N, Gana A.K, & Agboire, S. (2019). Evaluation of sugarcane hybrid clones for cane and sugar yield in Nigeria. *African Journal of Agricultural Research*, 14: 34-39

107 ISIGHTS INTO PREVALENCE AND DISTRIBUTION OF VIRUSES INFECTING MELON IN GEORGIA, UNITED STATE

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Abstract

Melons are important crops to Georgia's economy, over the past few years in *Southeastern USA* these crops have experienced a drastic decline in production because of economic important viruses majorly whitefly-transmitted viruses (WTVs) vectored by the *sweet potato whitefly complex (Bemisia tabaci). These viruses can be found as a single or mixed infection thereby causing significant yield loss and unmarketable fruits with reduced sugar content thereby shifting growers' attentions to other non-host crops mostly for the fall season crops. During the summer of 2021, surveys were conducted to evaluate the incidence and distribution of viruses infecting cantaloupe (n=88) and watermelon (n=269) in Georgia. Samples were collected from six major melon-producing counties in Georgia. The presence of two criniviruses cucurbit chlorotic yellows virus (CCYV), cucurbit yellow stunting disorder virus (CYSDV), the begomovirus cucurbit leaf crumple virus (CuLCrV), and ipomovirus squash vein yellowing virus (SqVYV) were tested using primers specific to these viruses with Reverse Transcriptase Polymerase Chain Reaction (RT-PCR) and PCR. None of the known viruses of cucurbits were detected from all the (n=357) samples suggesting the diversity of the virus during the summer season. This could be the effect of weather on virus prevalence in relationship with the vector and host interaction. This suggests that heavy rainfall according to what was experienced during the growing season in summer could have impacted vector buildup and virus transmission.*

108 GROWTH AND YIELD RESPONSES OF MAIZE TO PARTIAL SUBSTITUTION OF INORGANIC NITROGEN WITH FARM YARD MANURE AT GIDAN-KWANO

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Abstract

Maize is the third most important cereal in the world, next to rice and wheat. It is the most heavily cultivated cereal crop globally. A number of factors are responsible for the low yield of maize crop, among which fertilizer is key. This study was specifically carried out in 2019 farming season to determine the variations in growth and yield response of maize to partial substitution of inorganic nitrogen with farm yard manure at Gidan Kwano. The treatment consisted of the following combinations: (T1; 0% recommended nitrogen with 0% FYM), (T2; 25% recommended nitrogen with 75% FYM), (T3; 50% recommended nitrogen with 50% FYM), (T4; 75% recommended nitrogen with 25% FYM), (T5; 100% recommended nitrogen with 0% FYM), (T6; 0% recommended nitrogen with 100% FYM). The treatment was laid out in a Randomized Complete Block Design (RCBD) and replicated three times. Result of the study showed that plant height of maize was significantly affected by the treatment application, while number of leaves, leaf area and stalk girth showed a non-significant response. The result also showed that there was significant ($P<0.05$) differences among the treatments for days to 50% tasseling and days to 50% silking. Significant differences was recorded for cob dry weight, number of seeds per cob, 100 seed weight and total grain yield with the application of 50% N+50%FYM and 75%N+25%FYM. It is concluded based on the findings of the study that the integration or partial substitution of inorganic nitrogen and farm yard manure performed better than the use of inorganic nitrogen source or farm yard manure alone. The application of 50% N+50%FYM and 75%N+25%FYM is suggested for farmers in Gidan Kwano.

Keywords: Maize, Inorganic N, Farm yard manure, partial substitution

INTRODUCTION

Maize is a cereal crop grown in various agro-ecological zones, as a single crop or in mixed cropping. It is the third most important cereal in the world, next to rice and wheat and with highest production potential among the cereals (Prathyusha *et al.*, 2013). It is the most heavily cultivated cereal crop globally, and one of the main cereals crops of West Africa and the most important cereal food in Nigeria (Onuk *et al.*, 2010). Every part of the maize plant has economic value: the grain, leaves, stalk, tassel, and cob can all be used to produce a large variety of food and non-food products (IITA, 2009). World production of maize is around 790 million tones and it serves as a staple food providing more than one-third of the calories and proteins in some countries (Annual report, Decha District Agric Office, 2015). By 2050 demand for maize will double in the developing world, and maize is predicted to become the crop with the greatest production globally, and in the developing world by 2025 (Bemire, 2010).

A number of factors are responsible for the low yield of maize crop. Inappropriate crop nutrition management and poor soil fertility are the most important factors responsible for low yield (Arshad, 2003). The high cost, scarcity and low efficiency of fertilizer make them unprofitable for farmers, also without adequate supply of organic matter, continuous use of NPK fertilizer leads to soil acidification, nutrient imbalances and degradation of soil physical quality (Fasina, 2013). Therefore, this study was specifically design to determine the variations in growth and yield response of maize to partial substitution of inorganic nitrogen with farm yard manure at Gidan Kwano.

METHODOLOGY

Description of the study location

Field experiment was conducted during the 2019 cropping season at the Teaching and Research Farm of Federal University of Technology Minna, Gidan-Kwano Campus. (Lat 09˚ 31'N and Long. 06˚ 27'E of the equator, 212m above sea level.). The average annual rainfall ranges between 750mm-1250mm. Mean temperature ranges between 26^0C – 38^0C.

Experimental materials

Inorganic nitrogen (NPK 15:15:15), maize variety (Sammaz 34) were obtained from Kure market Minna and Farm Yard Manure (FYM) which was sourced from the Animal production farm of the Federal University of Technology Minna.

Treatment and Experimental Design

The treatment consisted of the following combinations: (T1; 0% recommended nitrogen with 0% FYM), (T2; 25% recommended nitrogen with 75% FYM), (T3; 50% recommended nitrogen with 50% FYM), (T4; 75% recommended nitrogen with 25% FYM), (T5; 100% recommended nitrogen with 0% FYM), (T6; 0% recommended nitrogen with 100% FYM).

The treatment was laid out in a Randomized Complete Block Design (RCBD) and replicated three times. The gross plot size was a 4m × 4m, with an inter plot spacing of 0.5 m and a 1m provided between the blocks.

Soil sampling and Analysis

A composited initial soil sample before planting was taken at 0-30 cm soil depth from the experimental site. The soil was processed following standard procedures and analyzed in the Soil Science Department laboratory of Federal University of Technology, Minna for organic matter content following the procedure by Walkley and Black (1934), total nitrogen by the Kjeldahl method (Bremner and Mulvaney, 1982). Soil reaction (pH-H2O) using a pH meter with 1:2.5 soil to solution ratio via a glass electrode attached, and Cation Exchange Capacity (CEC) leaching the soil with neutral 1 N ammonium acetate (FAO, 2008). Available phosphorous by Olsen et al., (1954); exchange able potassium by the use of flame photometer. The particle size analysis was done using the hydrometer method as outlined by Anderson and Ingram (1993)

Agronomic management of the experiment

All agronomic practices were implemented in accordance with the given recommendations for the crop. The field was cleared manually and ridged with a hoe. Ridges were spaced 75cm apart. Maize seed was sown manually on the 14th of July, 2019 at three seeds per hole with a planting depth of 5cm, at an inter and intra row spacing of 75cm × 25cm. The maize seeds were treated with Apron StarR (active ingredients Thiamethoxam, Mefanoxam and Difenoconazole at 10g per 4 kg seeds) before planting. Maize seeds were sown at the starting of rainfall, and the seedlings thinned to one plant per stand two weeks after sowing. Weeds were manually controlled at 3, 6 and 9 weeks after sowing (WAS).

Data collection

Phenological, growth, yield and yield components data were collected. The parameters taken were days to 50 % tasselling, days to 50 % silking, Plant height (cm), Number of leaves, leave area, stalk girth, dry cob weight, Number of seeds per cob, hundred (100) seed weight, and grain yield. All parameters were measured following the standard procedures. Growth data was taken at 9 weeks after planting (WAP).

Data analysis

Data collected were subjected to analysis of variance (ANOVA) using the Statistical Analysis System (SAS) software version 9.0 (2002). Where treatment means are significant, means were separated using Least Significant Difference (LSD) at 5% level of probability.

RESULTS AND DISCUSSION

Effect of partial substitution of inorganic fertilizer with farm yard manure (FYM) on the growth parameters of maize

Plant height

Result of statistical analysis for plant height shows a significant ($P<0.05$) difference among the treatments at 9 weeks after planting. Treatment one (0N:0FYP) recorded the shortest (168.83 cm) plant height (Table 1).The tallest (219.89 cm) plant was recorded in T4 (75:25) which was closely followed byT3 (50:50) and T2 (25:75) respectively ((Table 1).

Number of leaves, leaves area and stalk girth

The analysis of variance result for number of leaves, leaf area and stalk girth shows that all three parameters where non significantly affected by the treatments (Table 2). All treated plots performed better than the control plot (T1) across all parameters. Treatment T4 (75:25) recorded the maximum (12, 0.38 cm) values for leaf and stalk girth respectively. The reason for the non significant differences for these parameters could be attributed to the time of planting and the short period of drought witness during the season.

Table 1: Effect of partial substitution of inorganic fertilizer nitrogen with farm yard manure (FYM) on the growth of maize

Treaments	Growth parameters			
N:FYM	Plant height (cm)	No of leaves/plant	Leaf area (M^2)	Stalk girth (cm)
0:0	168.83b	10.83a	0.29a	0.30a
25:75	182.28ab	12.61a	0.36a	0.42a
50:50	217.67a	11.94a	0.38a	0.38a
75:25	219.89a	12.50a	0.32a	0.58a
100:0	206.39ab	11.39a	0.34a	0.37a
0:100	195.55ab	11.17a	0.32a	0.25a
SE±	6.61	0.26	0.12	0.06

Means followed by similar letter (s) with the same column are not significantly different at $p \leq 0.5$ according to Duncan's Multiple Range Test.

Effect of inorganic Nitrogen substitution with farm yard manure (FYM) on the phenology of maize

Days to 50% tasseling and Days to 50 % silking

The result showed that there was significant ($P<0.05$) differences among the treatments for days to 50% tasseling. Treatments T1 (0:0), T5 (100:0), and T6 (0:100) recorded the longest (54) number of days to 50% tasseling (Table 2) while T3 (50:50) and T4 (75:25) though statistically not significantly ($P<0.05$) different from each other, recorded the shortest (50) number of days to tasselling.

Statistically the result of days to 50% silking revealed that there was a significant ($P<0.05$) differences among the six treatments (Table 2). Treatments T1 (0:0) and T6 (0:100) showed the highest number to 50% silking followed by T2 (25:75), T5 (100:0) and T3 (50:50), while T4 (75:25) showed the lowest days to 50% silking (Table 2)

Table 2. Effect of inorganic fertilizer substitution with farm yard manure (FYM) on the phenology of maize.

Treatment N/FYM	Days to 50% tasseling	Days to 50% silking
0:0	54a	60.67a
25:75	52.32ab	58.33ab
50:50	50.33b	55.33bc
75:25	50.67ab	54.67c
100:0	54.00a	57.67abc
0:100	53.67ab	60.33a
SE±	0.51	0.65

Means followed by similar letter (s) with the same column are not significantly different at $p \leq 0.5$ according to Duncan's Multiple Range Test.

Effect of partial substitution of inorganic fertilizer with farm yard manure (FYM) on the yield attributes and yields of maize.

Dry cobs weight

The statistical analysis of the dry cob weight shows that there was a significant difference between the control plot T1 with no fertilizer when compared to all other treatment combinations (T2, T3, T4, T5, and T6). The lowest (2.43g) dry cob weight was recorded on T1 (0:0) while the highest (4.83g) cob dry weight was recorded for T3 (50:50) followed by T4 (75:25) with 4.20g (Table 3). With the exception of T1 (0:0) all the other treatments were not significantly different.

Number of seeds per cobs

The result of number of seeds per cob shows a significant difference (P<0.05) among the treatments (Table 3). The control plot T1 (0:0) recorded the minimum (319) while the maximum number of seeds per cob was recorded in T4 (75:25), followed by T3 with 392 seeds. Moreover, statistically not significant differences exist between T3, T4, T5, and T6 (Table 3).

Table 3: Effect of inorganic fertilizer substitution with farm yard manure (FYM) on the yield components and yield of maize

Treatments N:FYM	Dry cob weight (kg)	No of seed/cob	100 seed weight (g)	Grain yield kg/ha
0:0	2.43b	319.90c	20.07b	4000.00d
25:75	3.97a	357.43b	18.71c	6466.67b
50:50	4.83a	392.53a	18.77c	8200.00a
75:25	4.20a	396.57a	20.77a	7133.33b
100:0	4.13a	387.77a	18.74c	6666.67b
0:100	3.70a	375.17a	17.55d	5333.33c
SE±	0.31	14.20	0.45	1334.58

Means followed by similar letter (s) with the same column are not significantly different at $p \leq 0.5$ according to Duncan's Multiple Range Test.

100 seeds weight and total grain weight

Analysis of variance result showed that there was significant (P<0.05) difference in 100 seeds weight among the treatments. There was no significant difference (P> 0.05) between T2 (25:75), T3 (50:50), and T5 (100:0) for 100 seed weight. However, the maximum (20.77g) weight for 100 grain was recorded in T4 (75:25) followed by T1 (0:0) with 20.01g (Table 3).

Total grain weight (TGW) showed a marked significant difference (P<0.05) among the six treatments. Maximum total grain yield (8200kg/ha) was recorded in T3 (50:50) followed by T4 (75:25) which recorded a yield of 7133kg/ha (Table 3). Treatment one recorded the lowest yield (4000kg/ha).

DISCUSSION

The result obtained in this study indicates that the application of inorganic nitrogen along with farm yard manure is far better than the application of the individual sources for all the parameters measured. Maximum plant height was recorded for treated plots as against the untreated control plot. Plant height is as the appearance of full vegetative potential and initiation of reproductive phase. The reason for tallest plants in treatments with a combine application of inorganic nitrogen with farm yard manure might be due to availability and uptake of sufficient quality of nitrogen from inorganic source at early growth stages and farm yard manure (FYM) which provides better nutrition to the crop. Similar results were obtained by

Adnan Anwar Khan *et al.* (2017) where the nitrogen updates and soil fertility was highly significant for all growth parameters performance.

The total grain yield of maize as affected by the application of inorganic nitrogen and farm yard manure applied alone and or in combinations showed a significant differences. The highest grain yield of 8200kg/ha was obtained from treatment receiving inorganic source of nitrogen and farm yard manure at a ratio 50:50 followed by 7133.33kg/ha recorded for treatment receiving a ratio of N/FYM 75:25. The results indicated that treatment receiving nitrogen solely from NPK 15:15:15 or FYM produced lower yield compared with treatments receiving both inorganic source of nitrogen and farm yard manure. These results are in line with the findings of Shan *et al* (2007) who reported significant increase in grain yield of maize with integrated use of urea as source of Nitrogen and farm yard manure as compared to their sole application.

CONCLUSION AND RECOMMENDATION

In conclusion, the integrated or partial substitution of inorganic nitrogen and farm yard manure perform better than the use of inorganic nitrogen source or farm yard manure alone in terms of improving crop growth and yield. The application of 50% inorganic nitrogen with 50% farm yard manure and the application of 75% inorganic nitrogen with 25% farm yard manure were found to give the best maize crop performance at Gidan Kwano. Therefore, these combinations are suggested for farmers in the study area. Further experimental trial is needed to confirm this recommendation.

REFERENCE

Anderson, J. M. and Ingram, J. S. I. (1993). Tropical soil biology and fertility. A handbook of methods. 2nd Edition pp. 93-95.CAB International U.K

Arshad, M. Effect of different irrigation and nitrogen levels on growth and yield of maize. M. Sc. (Hons). Thesis, University of Agriculture, Faisalabad, Pakistan. 2003.

Bemire, A. S., T. Abdoulaye, D. Sanogo, and A. Langyintuo. (2010). Characterization of Maize Producing Households in the Dry Savannah of Nigeria.Country Report – Nigeria: IITA Ibadan, Nigeria 46pp.

Bremner, J. M. and Mulvaney, C. S. (1982). Nitrogen-total, in methods of soil analysis. Page, A. L. (Ed). Methods of soil analysis. Agronomy Monography 9. American Society of Agronomy. Madison, WI. 595-624 pp

Fasina, A.S. and Adeyanju (2013). Suitability classification of some granitic soils of humid west Nigeria for rain fed maize, cassava and swap rice production. Nigerian Journal of Soil Science 16:1-9.

Food and Agriculture Organization (FAO). (2008) Fertilizer Use by Crops in Pakistan. Pp: 4-24. 2004.

International Institute of Tropical Agriculture (IITA, 2009).International Institute of Tropical Agriculture, Ibadan, Oyo State.Annual Report on Maize production.

Olsen, S.R., Cole, F.S. and Dean, L.A. (1954). Estimation of Available Phosphorus in Soils by Extraction with Sodium Bicarbonate. USDA Circ. No. 939, Washington DC.

Onuk, E. G., Ogara I. M., Yahaya H. and Nannim N. (2010).Economic Analysis of Maize Production in Mangu Local Government Area of Plateau State, Nigeria.Nasarawa State University Keffi. 6(1): 1 – 11.

Prathyusha, C., S. Hemalatha, Sridhar and Sharana B. (2013).Growth and Productivity of Speciality Corn as influenced by different levels of Nitrogen under PongamiaPlantations.International Journal Technology.Volume-4, Issue-4.

Walkely, A. and Black, I.A. (1934). The Degitiareff Method for Determining Soil Organic Matter and a Proposed Modification of the Chromic Acid Titration Method. Soil Sciences, 34: 29-38.

109 RESPONSE OF GROWTH AND YIELD OF MAIZE (*ZEA MAYS* L.) TO LIME, INORGANIC AND ORGANIC FERTILIZER IN MOKWA, NIGER STATE OF NIGERIA

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Abstract

Proper integrated nutrient management is essential for plant growth, yield efficiency and soil health maintenance. A field trial was conducted to investigate the effect of lime, inorganic and organic fertilizer on growth and yield of maize on farmers' field at Rabba, Mokwa, Local government area of Niger State. The field trial was conducted in the year 2021 (rainy season). The treatments consisted of lime, organic, and inorganic fertilizer combinations. T^1: control (no input), T^2: 300 kg ha^{-1} of NPK (OCP special blended NPK micro nutrient fortified fertilizer), T^3: 0.5 t ha^{-1} Agric.- lime + 300 kg ha^{-1} NPK (OCP special blended NPK), T^4: 0.5 t ha^{-1} Agric.- lime + 5 t ha^{-1} cow dung (organic) + 300 kg ha^{-1}NPK (OCP special blended NPK), T^5: 5 t^{-1} ha of cow dung + 300 kg ha^{-1}NPK (OCP special blended NPK), arranged in Randomized Complete Block Design (RCBD) with three farmers' field as replicates. The gross plot size was 6 m x 6 m (36 m^2). The leaf area, husk with cob weight, cob weight and grain yield were measured as at when due. The results showed that maize were significantly improved with application of lime, inorganic fertilizer and organic manure with respect to all parameters taken as compared to the control which had the lowest growth and yield parameters across the farmers field in the study area, therefore the application of 0.5 t ha^{-1} Agric.- lime + 300 kg ha^{-1} NPK (OCP inorganic blend) + 5 t ha^{-1} cow dung recorded the highest yield of maize in the study area.

Keywords: Agric. - lime, OCP inorganic blend, Cow dung, Growth, Yield.

INTRODUCTION

Maize (*Zea mays* L.) is one of the important cereal crops in the world that provides essential nutrients for lactating mother for the sustainability of the baby and availability of vitamin A (contributes to the maintenance of normal skin, normal vision and normal function of the immune system). It is the third most important cereal crop after sorghum (S*orghum bicolor*) and millet (*Pennisetum glaucum*) in Nigeria and it is a major staple food that is used as fodder and industrial material with its production at both subsistence and commercial levels in the country (Eleweaya *et al.*, 2005). Maize required a fertile soil to do well. Cultivation of maize in Niger State is being affected by numerous number of factors such as soil acidity, inherent low fertility, imbalance nutrition management, unavailability of the right germplasm, flooding, weed infestation, insecurity, farmers - herdsmen crises, land tenure system, which limit the yield of crops in the state. Likewise modern crop production system is facing a sustainability problem due to indiscriminate use of chemical fertilizer and pesticides (Hidayatullah, 2015) that has resulted in depletion of soil organic carbon, decline in crop productivity and deterioration of nutrient content in the soil. In addition, the continuous and indiscriminate use of chemical fertilizers without organic sources leads to gradual decline of organic matter content and a change on native N status of the soil (Amanullah, 2016). Therefore adequate N sources (organic and mineral) and rates are very important to increase yield and reduce the cost of production and environmental pollution (Fu *et al.*, 2014; Pei *et al.*, 2015). However, chemical fertilizer is associated with decline in some soil properties and crop yields over time and causes serious land problems, such as soil degradation (Hepperly *et al.*, 2009). Integrated use of inorganic fertilizers with organic manures is a sustainable approach for efficiency nutrient usage which enhances efficiency of the chemical fertilizer while reducing nutrient losses (Schoebitz and Vidal, 2016). Farmer's attention hence needs to be drawn to the synergy which results from the combination of organic and inorganic fertilizer to combat food security challenges without soil health deterioration, hence ensuring bumper harvest. This study was designed to determine the influence of combined application of Agric. -lime, inorganic and organic minerals on the growth and yield of maize in the study area.

This study was designed to:

Determine the influence application of Agric. -lime, inorganic and organic minerals on the growth and yield of maize in the study area.

MATERIALS AND METHODS

Description of the study area:

Field trials were carried out at farmer's field (on-farm) at Rabba, Mokwa Local Government Area of Niger State, situated in Southern Guinea Savannah zone of Nigeria. Three farmers field were selected. The experiment was conducted during the 2021 cropping season. The trial field was located at latitude 09^0 13 $^-$ 78^{0}" N and longitude 05^{0}' 01' 761"E, with an elevation of 117m, with mean annual rainfall of 1165.0 mm and mean annual temperature of 26.74^{o}C.

Sources of Experimental Materials:

Pioneer Var. Oba super II was obtained from Agricultural Development project (ADP) farm center Minna, Niger State. Cow dung was collected from animal teaching and research farm Federal University of Technology Minna. OCP special blended NPK micro nutrient fortified fertilizer (11N-22-p-22k-1$B_2 0_3$-1zn) at 300 kg ha^{-1}, Agric. - lime at 0.5 t ha^{-1}, Urea (46 % N) at 189.13 kg ha^{-1} were all gotten from ADP Minna.

Soil Sampling and Analysis:

Soil samples were collected with a soil auger from the field randomly from 15 points in the entire field at a depth of 0-20 cm. The collected samples were bulked and thoroughly mixed to form a composite sample. The composite soil sample was taken to the laboratory for routine analysis. The sample was air-dried, gently crushed and passed through a 2 mm sieve. The sieved soil was used for determination of soil physical and chemical properties. The soil sample was analyzed according to standard procedures as described by Agbeni (1995). Particles size distribution was determined by Bouyoucos hydrometer method, soil pH was determined in 1:2.5 soil to water and 0.1 M $Cacl_2$ using a glass electrode pH meter. Organic carbon was determined using Walkley-Black method, total nitrogen was determined by micro-Kjeldal method, exchangeable bases (Ca^{2+}, Mg^{2+}, K^+ and Na^+) was extracted with IN neutral ammonium acetate (NH_4OAC) solution and amounts of potassium and Na in solution was determined using flame photometer, calcium and magnesium by sodium EDTA titration method, exchangeable acidity (H^{2+} and Al^{3+}) was determined by titrimetric method with standard sodium hydroxide (0.5 N NaOH) and Effective Cation Exchange Capacity by summation method. Cow dung was also analyzed for N, P and K content.

Treatments and Experimental Design:

Treatment consisted of:

T1 = Control (No input)

T2 = 300 kg ha^{-1} of OCP special blended NPK

T3 = 0.5 t ha^{-1} of Agric. – lime + 300 kg ha^{-1} OCP special blended NPK + Urea

T4 = 0.5 t ha^{-1}of Agric. - lime + 300 kg ha^{-1} OCP special blended NPK + 5 t ha^{-1} Cow dung

T5 = 5 t ha^{-1} Cow dung + 300 kg ha^{-1} OCP special blended NPK The experimental design was a 6 m by 6 m with 1 m apart arranged on a Randomized Complete Block Design (RCBD) with three farmer's field as replicates.

Land Preparation and Agronomic Practices:

The land was cleared manually using simple hand hoe and cutlass. Six (6) ridges were constructed manually with hoe (6 m length) with an inter-row spacing of 75 cm on each plot size of 36 m^2.

Application of Agric. – lime 0.5t ha $^{-1}$ and cow dung at 5 t ha^{-1} each was done on the field after land preparation by incorporating into the soil 2 weeks before sowing, three maize seeds were sowed and supplying was done a week after sowing, plants were thinned to one plant per stand

2 weeks after sowing. Manual weeding was done at 3 and 6 WAS to keep the experimental field weed-free. Fertilizer application of OCP inorganic blend, NPK micro nutrient fortified fertilizer (11N-22P-22K-1B_2O_3-1Zn) at 300 kg ha^{-1} was immediately done after sowing. Top dressing was done 5 weeks after sowing using urea (189.13 kg ha^{-1}) the total inorganic fertilizer (OCP and Urea) supplied was 120 kg N, 66 kg P_2O_5, 66 kg K_2O ha^{-1}.

Data Collection at Growth Stage:

Data were collected on the following parameters on 8 tagged plants per plot size of 36 m^2 at 6, 8, 10 and 12 WAS. The leaf length and width of the plant tagged were measured using measuring tape multiply by 0.75 (i.e., leaf factor) and was expressed in centimeter square (cm^2). Day to 50 % tasselling was taken at 7 WAS (when half of the plants had tasseled) by visual observation.

Data Collection at Harvest:

The cobs were harvested manually at crop maturity when 90 % of the cobs in the experimental plots turn from green to straw colour (brownish yellow) at about 90-95 days after sowing. Number of cobs on tagged plants was counted and the average was calculated and recorded at harvest. Dry cobs with husk and dehusk cobs were weighed using manual weighing balance (scale) which was expressed in kg ha^{-1}. Grain yield of the plant tagged was weigh using manual weighing balance and been expressed in kg ha^{-1}.

Data Analysis:

The data collected were subjected to statistical analysis using GENstat 11th edition (2000). Treatment means were separated using Duncan Multiple Range Test (DMRT) at 5 % level of probability.

RESULTS AND DISCUSSION:

The results of cow dung analysis are shown on Table 1. The result revealed that, cow dung contain 2.52 Nitrogen (%) , 0. 04 Phosphorus (%) and 0.39 Potassium (%).The results of the routine analysis are shown on Table 2. It revealed that the soil pH was moderately - acidic in nature. The soil organic carbon was very low (4.77 – 5.74 %) likewise the percent nitrogen was moderately. However it was noted that the available phosphorus was low. The exchangeable Ca was low in location 1, 2 and very low at location 3. Exchangeable Mg was moderate at locations 1, 2 and low at 3 (1.80, 1.40 and 0.50) respectively. K was low (0.16, 0.22 and 0.14), while Na was moderate at location 1, 2 and low at location 3 (0.40, 0.47 and 0.18), the soil texture is sandy loam in nature. The available micronutrients analyzed (Zinc, Molybdenum and Boron) were all very low in the study sites. Hence, the need for an integrated nutrient management system, to argument the limiting nutrients in the soil and to improve and sustain maize growth and yield in the study area. The widest leaves produced with the application of OCP inorganic blend + Urea, Agric. – lime + OCP + Urea, Agric. – lime + OCP + Cow dung + Urea and Cow dung + OCP + Urea could be attributed to improvement of soil physical and chemical properties of the soil and the supply of sufficient nutrient required for optimum growth of maize. This finding is in conformity with Dasog *et al.*, (2012) who reported that balanced application of NPK fertilizers with farm yard manure (FYM) and lime improve sustainable crop productivity and growth of maize. Amit and Auwal (2017) also reported that significant increase in leaf area were observed due to the effect of integrated nutrient management more than sole application of recommended dose of fertilizer. Grain yield is the end result of many complex morphological and physiological processes during the growth and yield development of crop. The heaviest cobs and highest grain yield produced with the application of Agric. – lime + OCP inorganic blend + Cow dung + Urea could be attributed to its multifaceted potential for the improvement of plant performance and resource efficiency while also enabling the protection of the environment and resource quality, this is also in line with khan *et al.*, (2008) report. The result is in line with those reported previously (Nagassa *et al.*, 2005 and Shah *et al.*, 2009) who revealed that grain yield was significantly affected by fertilizer in combination with farm yard manure likewise Ayoola and Makinde (2009) observe increased nutrient use efficiency with the combination of inorganic and organic manure.

The treatment combinations might have led to the restoration of soil fertility thereby sustaining crop productivity via the availability of organic matter, major and micronutrients enhancing nutrient use efficiency and favouring the physical, chemical and biological status of the soil. This is confirmed by Golla (2020) who reported that the increase in grain yield of maize might be due to improved physical and chemical properties of the soil through the application of organic manure and adequate quantities and balanced proportions of plant nutrients supplied to the crop by the integrated nutrient management as per needed during the growth period resulting in favorable increase in yield attributing characters which ultimately led towards an increase in economic yield of maize. This study also confirmed that grain yield was significantly higher under integrated nutrient management than unfertilized and chemical fertilizer alone. According to Kakraliya *et al.*, (2017), wheat yield with synthetic fertilizer (NPK) 42 % more compared with control (unfertilized), and further increased with the use of organic and inorganic fertilizer along with bio-fertilizers.

Table 1: Cow dung analysis.

Nitrogen (%)	Phosphorus (%)	Potassium (%)
2.52	0.04	0.39

Table 2: Soil routine analysis per farmer's field.

Soil properties	Location 1	Location 2	Location 3
pH	5.7	5.8	6.0
Organic Carbon (%)	4.77	4.77	5.74
Total Nitrogen (%)	0.62	0.53	0.52
Available P (mg kg^{-1})	4.82	7.00	9.24
Exchangeable Cation (cmol kg^{-1})			
Ca	2.00	3.50	3.40
Mg	0.80	3.70	1.00
K	0.16	0.18	0.09
Na	0.35	0.30	0.29
Particle size Distribution (g kg^{-1})			
Sand	858	858	838
Silt	30	10	20
Clay	112	132	142
Textural class	LS	LS	SL

Table 3: Effect of organic and inorganic nutrient management on maize number of leaf area

	Leaf area (cm^2)			
Treatments	6 WAP	8 WAP	10 WAP	12 WAP
Control	267.18b	339.38b	424.06b	72.81b
OCP/Urea	436.56a	546.25a	592.29a	154.69a
Agric.- lime/OCP/Urea	448.75a	46.50a	626.50a	138.44a
Agric.- lime/OCP/Cow dung/Urea	435.94a	545.31a	639.71a	169.38a
Cow dung/OCP/Urea	457.81a	560.00a	597.56a	132.50a
SE±	25.10	28.20	16.99	34.39

Table 4: Effect of organic and inorganic nutrient management on maize yield

Treatments	weight of dry husk plus cob ($plant^{-1}$)	weight of dry cob ($plant^{-1}$)	grain yield (kg ha^{-1})
Control	138.88c	74.07c	277d
OCP/Urea	388.88b	296.29b	14814c
Agric.- lime/OCP/Urea	444.44b	342.59b	19444b
Agric.- lime/OCP/Cow dung/Urea	564.81a	490.74a	2592a
Cow dung/OCP/Urea	444.44b	361.10b	1759bc
SE±	21.32	21.32	8.78

Conclusions

From the results of this study, it was concluded that the application of OCP special blended NPK + Urea, Agric. - lime + OCP special blended NPK + Urea, Agric. – lime + OCP inorganic blend + Cow dung + Urea and Cow dung + OCP special blended NPK + Urea significantly produced similar taller plants, highest number of leaves and largest leaves than the control, which had the shortest plants, lowest number of leaves and smallest leaves in Raba, Mokwa local government. The application of Agric. – lime + OCP special blended NPK + Cow dung

+ Urea produced heaviest cobs and highest grain yield compared with the control which had the lightest cobs and lowest grain yield on the farmers field in the study area.

Recommendations

Based on the context of this study, it is recommended that farmers in Raba, Mokwa local government area of Niger State of Nigeria should adopt:

(iii) The application of OCP special blended NPK /Urea, Agric. - lime/OCP special blended NPK /Urea, Agric.- lime/OCP inorganic blend/Cow dung/Urea and Cow dung/OCP/Urea for increased growth of maize in case the objective is to produce fodder crop.

(iv) While the application of Agric. - lime/OCP special blended NPK /Cow dung/Urea for higher yield and yield attributes of maize for grain production.

References:

Ayoola, O.T. & Makinde, E.A. (2009). Maize growth, yield and soil nutrient changes with aenriched organic fertilizers. *African Journal of food, Agriculture and Nutrition* 9:580-592

Amanullah, H. (2016). Influence of organic and inorganic nitrogen on grain yield and yield components of hybrid rice in Northwestern Pakistan. *Rice Science*, 23 (6): 326-333 www.sciencedirect.com

Amit, K. & Auwal, T.W. (2017). Effect of integrated nutrient management on growth and yield parameters of maize (Zea mays L.) as well as soil physico-chemical properties. *Journal of Scientific and Technical Research*, 1(2), 1 – 6.

Dasog, V.G.S., Babalad, H.B., Hebsur, N.S., Gali, S.K., Patil, S.G &Alagawadi, A.R. (2012). Nutrient status of soil under different nutrient and crop management practices. *Karnataka* 4.*Journal of Agricultural Science*, 193 – 198.

Eleweanya, N.P., Uguru, Mi., Enebong, E,E., & Okocha, P. I., (2005) Correlation and path coefficient analysis of grain yield related characters in maize (*Zea mays L.*) under Umudike condition of south Eastern Nigeria . *AgroScience Journal of Agriculture, Food Environmental and Extension* 4(1) : 24-28.

FU J., Wang Z. Q., Yu L. M., and Yang, J.C. (2014). Effect of growth and yield response of interrogated maize (Zea mays L.). To the application of different rates of inorganic fertilizer and poultry manure.

Golla, B. (2020). Role of integrated nutrient management for enhancing nitrogen use efficiency in crop. *Open Journal of Plant Science*, 5(1), 1 – 12.

Happerly Y.P. lotter, D., Ulsh, C. Z. Siedel R. & Reider, C. (2009). Compost manure and synthetic fertilizer influence crop yields, soil properties, nitrate leaching and crop nutrient content compost Science Util 17, 117 -126 (links)

Hidayyatulla A. (2015). Sources rations and mixture of organic and inorganic nitrogen influence on plant height of hybrid rice (*Oryza sativum*) at various growth stages of Agriculture 2(3) 328-337

Kakraliya, S.K., Jat, R.D., Choudhari, K.K & Prakash, J. (2017). Integrated nutrient management for improving, fertilizer use efficiency, soil biodiversity and productivity of wheat in irrigated rice wheat cropping system in Indo-Gangatic plains of India. *Journal of Current Microbiology and Applied Science*, 6, 152 – 163.

Kalhapure, A.H., Shete, B.T. & Dhonde, M.B. (2013). Integrated nutrient management in maize (*Zeamays* L.) for increasing production with sustainability. *International Journal of Agriculture and Food Science Technology*, 4, 195 – 206.

Pei, P.G., Zhang J.H., Zhu L.F., Hu, Z.H. & Jin, Q.Y. (2015). Effect of straw returning coupled with application on rice photo synthetic characteristic, nitrogen uptake and grain yield formation

Shah, S.T.H., Zamir M.S.I. & Khalid, W.B. (2009). Growth and yield response of maize (Zeamays L.) to organic and inorganic sources of nitrogen. *Pakistan Journal of Life Social Science* 7: 108-111

Schoebitz, M., & Vidal, G. (2016). Microbial consortium and pig slurry to improve chemical properties of degraded soil and nutrient plant uptake *Journal. of Soil Science. plant Nutr*ition 16(1), 226-236 (links) china journal of rice scien.

110 UNDERSTANDING THE INTENTION TO USE GOOD AGRICULTURAL PRACTICES ON VEGETABLE FARMS – A COMPARATIVE STUDY OF FARMERS IN PUNJAB, INDIA AND NAKURU, KENYA

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Abstract

Good Agricultural Practices (GAP) are protocols that address farm production and post-harvest practices which contribute to food safety, quality, socio-economic viability, environmental sustainability, and animal welfare. India and Kenya have adopted GAP standards successfully among export-oriented large scale vegetable farmers, mostly through joint public-private initiatives. Focus is shifting to small-scale farmers who risk being marginalized from the markets unless they get adequately informed, technically prepared, and culturally organized to exploit the standards. Vegetables are highly vulnerable to pathogen and microbial contamination. GAP is one way of addressing this risk. However, the adoption of GAP among small-scale vegetable growers has remained a challenge. By use of the Theory of Planned Behaviour, this paper explores the psychological factors underlying intention to adopt GAP among vegetable growers in India and Kenya. The results demonstrate that in Punjab, the intention to adopt GAP is significantly influenced by attitude ($\chi 2$ (1, N=100) = 36.327, p <.001); whereas in Nakuru, attitude and subjective norms ($\chi 2$ (1, N=100) = 4.003, p =.045 and $\chi 2$ (1, N=100) = 11.565, p <.001) significantly influenced the intention to adopt the protocols. Perceived Behavioural Control had no significant influence on intention to adopt.

Key words:

Attitude, Good Agricultural Practices, Perceived Behavioural Control, Subjective Norms, Theory of Planned Behaviour.

Introduction

Vegetable consumption has gained increased popularity among health-conscious consumers as a source of nutrition (IFPRI, 2014). However, vegetables are prone to on-farm pathogenic contamination and subsequent foodborne illness outbreaks (DeWaal *et al*., 2008). Disease occurrence from vegetable contamination is of global public health concern (Lynch *et al*., 2009). Vegetables linked contamination has resulted in approximately 46% of yearly foodborne illnesses in Europe and America (EFSA 2017); sickness in over 150 million, and death in 175 thousand people in Asia (WHO, 2015); and costs of foodborne diseases in Africa exceeding $US1 billion (WHO, 2016). Consequently, there is a shift to focus on vegetable safety and quality both at the domestic and foreign markets (Alonso *et al*., 2019).

The demand for quality and safety in vegetables led to the introduction and promotion of common principles and standards for production, commonly referred to as Good Agricultural Practices (GAP) by the Food Agriculture Organisation (FAO) (Alonso *et al*., 2019). GAP is a voluntary codified system that is related to practical, efficient on-farm and off-farm processes aimed at reduction in chemicals and pesticide use, sustainable utilization of natural resources, promotion of occupational health and safety for farm workers and animal welfare (Amekawa 2010; Islam, 2012).

India and Kenya have reported some success in integrating small-scale farmers into GAP certification programs through joint public-private initiatives (Henson & Jaffee 2008; Pandit *et al.*, 2017). However, these cases are limited in scale and scope to large scale farmers and contracted smallholder farmers. Several ordinary small-scale vegetable farmers may have been omitted due to a lack of membership in any producer group associations that work with specific contracted small-scale farmers, hence losing out on the benefits associated with GAP (Carey, 2008).

Theory of Planned Behaviour (TPB) is one of the most popular social-psychological models for predicting behavior (Ajzen, 2011). TPB assumes that human behavior is reason-based and guided by three independent constructs that arise out of behavioral beliefs, attitudes, subjective norms, and perceived behavioral control. TPB's central argument is that a specific behavior depends on the intention to perform it and the perceived behavioral control (Giampietri *et al.*, 2017).

TPB has been used extensively in decision-making contexts in various disciplines. However, the influence of intention, attitude, subjective norms, and perceived behavioral control among vegetable growers in their decision to adopt GAP needs further study. The objectives of the paper are twofold. i) To determine the attitudes, subjective norms, perceived behavioral control, and behavioral intentions among smallholder vegetable growers towards GAP on their farms, ii) to explore the influence of attitudes, subjective norms, and perceived behavioral controls on vegetable growers' intentions to adopt GAP. To guide the study, the following hypotheses were developed from the TPB framework;

H1: The attitude towards GAP significantly influences the vegetable grower's intention to GAP protocols.

H2: The subjective norms significantly influence the vegetable grower's intention to adopt GAP protocols.

H3: The perceived behavioural control significantly influences vegetable grower's intention to adopt GAP protocols.

2.0 Materials and methods

Purposive sampling method was used to select vegetable growers' associations in Punjab, India and Nakuru, Kenya. A list of farmers was obtained from the associations; then 100 farmers were randomly selected from each list, personally visited and interviewed by use of a semi-structured questionnaire interview schedule. A total of 200 farmers formed the study sample size.

To measure behavioural intention, questions were posed to the respondents on a semantic differential scale with expectation of strongly disagree/strongly agree response on a scale of 1 to 7. The mean score of the responses was taken; and this was used as the behavioural intention score for each farmer. To carry out measurement of attitude towards different GAP protocols, bipolar evaluative adjectives such as 'good-bad' were used to evaluate specific practices performed by the farmer.

Measurement of subjective norms involved the use of questions referring to the opinions of people considered important to the vegetable grower, such as family members, fellow farmers, consumers and extension personnel among others.

To determine perceived behavioural control score, measurement was done on a farmer's self-efficacy and their beliefs about the controllability of their actions. Self-efficacy was measured by asking farmers to report on how difficult it was to perform specific practices related to vegetable cultivation; and how confident they were that they could do it. Controllability was measured by asking farmers to report on whether performing the practise was up to them or whether factors beyond their control determined their actions.

Descriptive statistics were then used to calculate the frequencies and percentages of the vegetable growers distributed in each category of the four constructs of TPB. A Pearson chi-square test was conducted to examine whether there was a relationship between attitude, subjective norms and perceived behavioural control of the vegetable growers to adopt GAP and their behavioural intention to do so, once the data m*et al*l the requirements of chi-square te st.

Results

The results show that 78% of the sampled vegetable growers in Punjab and 85% of those in Nakuru were high intenders; 80% of the farmers in Punjab and 86% in Nakuru had positive attitude towards GAP protocols; 90% of the farmers in Punjab and 99% of those in Nakuru had no social pressure towards using GAP protocols; 48% in Punjab and 56% in Nakuru felt they were in control of their actions, while 52% of the growers in Punjab and 44% of those in Nakuru felt they had no control of their actions.

Table 1: Socio-psychological constructs among vegetable growers

S. No.	Construct	Categories	Punjab		Nakuru	
			f	*(%)*	*f*	*(%)*
1	Behavioural Intentions	High Intenders	78	78.0	85	85.0
		Low Intenders	22	22.0	15	15.0
2	Attitude	Positive Attitude	80	80.0	86	86.0
		Negative Attitude	20	20.0	14	14.0
3	Subjective Norms	Presence of social pressure	10	10.0	1	1.0
		Absence of social pressure	90	90.0	99	99.0
4	Perceived Behavioural Control	No control	52	52.0	44	44.0
		In control	48	48.0	56	56.0

Source: Field survey, 2021

Findings also showed that there is a significant relationship between attitude and behavioural intention among vegetable growers in Punjab, χ^2 *(1, N=100) = 36.327, p <.001*, and Nakuru χ^2 *(1, N=100) = 4.003, p =.045*, with 64% of the farmers in Punjab and 85% of those in Nakuru having high intention to adopt the protocols as a result of their positive attitude towards them. Attitude therefore significantly influences the intention to adopt GAP. Consequently, H1 is supported.

The results further show that there was no significant relationship between subjective norms and behavioural intention in Punjab, χ^2 *(1, N=100) = .414, p =.045* even though 71% of the respondents expressed being exposed to high social pressure towards adoption of GAP. Subjective norms therefore do not significantly influence the intention to adopt GAP, thus the result is in contrast to the TPB, as a significant influence is assumed. Comparatively, there was a significant relationship between subjective norms and behavioural intention to adopt GAP in Nakuru χ^2 *(1, N=100) = 11.565, p =.001;* with 85% of the farmers having faced high social pressure to adopt GAP. As was hypothesized, subjective norms have significant influence on the respondents' intention to adopt GAP.

The relationship between Behavioural Intention and Perceived Behavioural Control was also not significant, hence showing that this did not significantly influence the intention to adopt GAP among vegetable growers in Punjab χ^2 *(1, N=100) = 1.908, p =.167*, as well as those in Nakuru χ^2 *(1, N=100) = .405, p =.525*. The results do not support the significant influence assumption as hypothesized by TPB.

Table 2: Socio-psychological effects on smallholder vegetable growers' behavioural intentions

Behavioural Intention	Punjab						Nakuru					
	Attitude		Subjective Norms		Perceived Behavioural Control		Attitude		Subjective Norms		Perceived Behavioural Control	
	-	+	low	high	none	control	-	+	low	high	none	control
Low Intention	19	3	3	19	3	19	2	13	2	13	2	13
High Intention	14	64	7	71	4	74	2	83	0	85	7	78
$\chi^2_{(1)}$	*36.327***		*.414(.520)*		*1.908(.167)*		*4.003(.045)*		*11.565***		*.405(.525)*	

*Note **p<.001, - (negative), + (positive)   Values in parentheses are significant levels.*

Discussion

The results indicated that TPB was useful in understanding behavioural intention to adopt GAP protocols in the context of smallholder vegetable growers in Punjab, India and Nakuru, Kenya. It has revealed that attitude significantly influences intention to adopt GAP in Punjab and in Nakuru. A possible explanation for the positive attitude towards GAP among the farmers in the two regions could be as a result of to their awareness to the benefits that can accrue from following the protocols; benefits such as better market access, increased prices and profitability as well as environmental conservation (Senger *et al*., 2017). This result agrees with previous TPB studies which found attitude to be a significant predictor of intention to adopt voluntary agricultural practices (Zeng and Cleon, 2018); and also agrees with Ajzen, (2011) whose summary of different meta-analyses and reports found that for a wide range of behaviours, attitudes have a mean correlation with intentions of between 0.45 and 0.60.

Subjective norms do not significantly influence the intention to adopt GAP in Punjab. Since subjective norms according to Werner *et al* (2017) and Burton, (2004) is conceptualized as pressure received from significant others, it can be implied that the results can indicate some form of protest against expectations from politics or society (Fielding *et al*., 2008); an observation which could be quite possible given the protest against farm laws in Punjab that was happening when the study was being conducted. Subjective norms in Nakuru on the other hand significantly influenced the intention to adopt GAP. A possible explanation for the findings is that different reports have been provided lately focusing on chemical residue in vegetables within Nakuru (KEPHIS 2017; Mbae *et al.*, 2018). This may have led to introduction and enforcement of stringent new laws and market standards that brought about fear of penalties, hence motivating the vegetable growers to behave in a way that is perceived as 'socially desirable' (Mills *et al*., 2017). Wauters *et al.* (2010) and van Dijk *et al.* (2016) also found statistically significant effects of subjective norm on the intention to perform conservation and agri-environmental measures, respectively.

Perceived behavioural control among vegetable growers in the two regions does not significantly influence the intention to adopt the protocols. A possible explanation for this finding could be that the vegetable growers are not familiar enough with the protocols of GAP and therefore the measured items may not have been accurate enough to capture the actual behavioural control (Ajzen 2011). Another possible explanation could be that there was lack of suitable levels of self-efficacy among vegetable growers, since previous studies have found that in such scenarios, it is not the lack of motivation to adopt recommended practices, instead it is the lack of suitable levels of perceived efficacy to take action (Wilson *et al*., 2018). Zeweld *et al*., (2017) did not find a significant relationship between perceived behavioural control and farmers' intentions to adopt sustainable practices; neither did Van Dijk *et al*. (2016) find a statistically significant effect for the perceived behavioural control to adopt agri-environmental measures. In contrast, Fielding *et al*. (2008) reported a statistically significant effect of Perceived Behavioural Control on the intention for the implementation of sustainable agricultural practices.

Conclusion

The Theory of Planned Behaviour has allowed the identification of socio- psychological factors that motivate vegetable growers' intention to adopt GAP. Attitude and subjective norms have been identified as the major determinants of the intention to adopt; whereas perceived behavioural control is not. However, the results imply also that social pressure in Punjab might not be purposeful to enhance overall adoption and could lead to opposition. Overall, there is relevance of TPB psychological constructs in understanding vegetable growers' behaviour in the context of Good Agricultural Practices (GAP).

The study focused on the psychological factors underlying farmers' intention to adopt. Further research could include socio-economic and policy characteristics, to evaluate vegetable growers' ability to adopt GAP (Mills *et al*., 2017).

References

Ajzen, I. (2011) Behavioral interventions: Design and evaluation guided by theory of planned behaviour. In: M.M. Mark, S.I. Donaldson & B.C. Campbell (Eds.), So*cial psychology program and policy evaluation* (74-100).Guildford, New York.

Alonso, G.D., Roesel, S., Covic, K. N., & McDermott, J. (2019 February 12–13). *Food safety in Africa and strategic directions for improving policy and regulatory frameworks.* (Paper presentation). Trade of safe food in free trade areas at the first FAO/WHO/AU International Food Safety Conference, Addis Ababa.

Amekawa. Y. (2010). Rethinking sustainable agriculture in Thailand: A governance perspective. *Journal of Sustainable Agriculture*, 34(4), 389-416.

Burton, R.J. (2004) Reconceptualising the 'behavioural approach'in agricultural studies:a socio-psychological perspective. *J Rural Studies* 20: 359-71.

Carey C. (2008). Governmental use of voluntary standards*: Kenya and the KenyaGAP Standard for Good Agricultural Practice.* (Case study 6, ISEAL Alliance). London.

DeWaal, C. S., X. A. Tian, & F. Bhuiya. (2008). Outbreak alert! 2008: *Closing the gaps in our federal food-safety net.* Center for Science in the Public Interest. https://cspinet.org/sites/default/files/attachment/outbreak_alert_2008_report_final.pdf.

European Food Safety Authority (EFSA) (2017). Shiga toxin producing *E. coli* outbreak(s). http://www.efsa.europa.eu/en/topics/topic/ecolioutbreak

Fielding, K.S., Terry, D.J., Masser, B.M., Hogg, M.A. (2008). Integration social identity theory and the theory of planned behavior to explain decisions to engage in sustainable agricultural practices. *Br. J. Soc. Psychol*. 47 (1), 23–4.

Giampietri, E., Verneau, F., Del G.T., Carfora, V., Finco, A. (2017). Telling the trust about consumers: A Theory of Planned Behaviour perspective to investigate the role of trust in consumer purchasing decisions related to short food supply chains. *Food Quality and Preference*. 64, 160-166.

Henson, S., & Jaffee, S. (2008).Understanding developing country strategic responses to the enhancement of food safety standards. *The World Economy*. 31(4), 548-568.

International Food Policy Research Institute (IFPRI, 2014). *2013 Global food policy report*. Washington, D.C. International Food Policy Research Institute (IFPRI)

Islam, G., Arshad, F., Radam, A., & Alias, E. (2012). Good agricultural practices (GAP) of tomatoes in Malaysia: Evidences from Cameron Highlands. *African Journal of Business Management, 6 (27)*, 7969-7976.

Kenya Plant Health Inspectorate Service (KEPHIS, 2017). *Annual Report and Financial Statements for the year ended 30th July 2017*. KEPHIS. http://www.kephis.org/images/docs/2017annualreportforwebsite.pdf

Lynch, M. F., Tauxe, R. V., & Hedberg, C. W. (2009). The growing burden of foodborne outbreaks due to contaminated fresh produce: risks and opportunities, *Epidemiology and Infection*, 137(3), 307–315.

Mbae, K., Mercy M., Ndwiga K., Kiruki F.G. (2018). Microbiological quality of *kachumbari*, a raw vegetable salad popularly served alongside roast meat in Kenya. *Journal of Food Quality*, 1 (6), 7

Mills, J., Gaskell, P., Ingram, J., Dwyer, J., Reed, M., & Short, C. (2017) Engaging farmers in environmental management through a better understanding of behaviour. *Agric Hum Values.* 34 (2), 283–299.

Pandit, U. & Nain, M.S. & Singh, Rashmi & Kumar, S. & Chahal, V.P. (2017). Adoption of Good Agricultural Practices (GAPs) in Basmati (Scented) rice: A study of prospects and retrospect. *Indian Journal of Agricultural Sciences* .87 (1), 36-41.

Senger, I., Borges, J., Machado, J. A. (2017). Using the Theory of Planned Behavior to understand the intention of small farmers in diversifying their agricultural production. *Journal of Rural Studies*. 49 (7), 32-40.

van Dijk, W., Lokhorst, A., Berendse, F., & Snoo, G. R. (2016). Factors underlying farmers' intentions to perform unsubsidised agri-environmental measures. Land Use Policy. 59(59), 207-216.

Wauters E, Bielders C, Poesen J, Govers G, Mathijs E (2010) Adoption of soil conservation practices in Belgium: An examination of the theory of planned behaviour in the agrienvironmental domain. Land Use Policy 27 (1):86–94.

Werner, M., Wauters, E., Bijttebier, J., Steinmann, H-H., Ruysschaert, G., Knierim, A. (2017) Farm level implementation of soil conservation measures: Farmers' beliefs and intentions. *Renew. Agric. Food Syst*. 32 (6), 524–537.

World Health Organization. (WHO, 2015). *WHO estimates of the global burden of foodborne diseases: foodborne disease burden epidemiology reference group 2007-2015*. World Health Organization.

World Health Organization. (WHO, 2016). *World health statistics 2016: Monitoring health for the SDGs, sustainable development goals.* World Health Organization.

Wilson, R.S., Schlea, D.A., Boles, C.M.W., & Redder, T.M. (2018). Using models of farmer behavior to inform eutrophication policy in the Great Lakes. *Water Res.* 139, 38–46.

Zeng, Z., Cleon, C.B., (2018). Factors affecting the adoption of a land information system: An empirical analysis in Liberia. Land use policy 73, 353–362.

Zeweld, W., Van Huylenbroeck, G., Tesfay, G., & Speelman, S. (2017). Smallholder farmers' behavioural intentions towards sustainable agricultural practices. Journal of Environmental Management, 187(1), 71–81.

111 DETERMINATION OF DRY SEASON IRRIGATION WATER QUALITIES FOR VEGETABLE PRODUCTION IN MINNA, NIGERIA

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Abstract

This research was carried out to determine microbial loads in irrigation water and vegetables under dry season production in Minna. Irrigation water, fruits and leafy vegetables were collected from six farms. The samples were collected and checked in the laboratory. The results revealed that all the sampled farms have the presence of bacteria and fungi loads. However, the irrigation water used for irrigating the plants has high bacteria counts and low fungi counts. The high bacteria count in the irrigation water can be best thought to be from the source of water, which makes the leafy vegetables has high bacteria count. The fungi count on the vegetables were higher than the irrigation water, which have resulted from the manure used as fertilizers or the hygiene level of the area. It is recommended that consumers should ensure the produce are hygienic before eating especially the vegetables that are eaten raw. It is also recommended that farmers should ensure the use of quality water for irrigating their farms in dry season. To meet the all year-round demand of vegetable and fruits in the middle-belt region of Nigeria, irrigation with any available source of water is a common practice by the local farmers.

Introduction

Fruits and leafy vegetables are exceptional dietary source of nutrients, micronutrients, vitamins and fibre for human beings hence vital for health and fitness (Tsado *et al*., 2013). Foods rich in fruits and vegetables, are especially valuable for their ability to prevent deficiencies of vitamin C and vitamin A and also reduce the risk of several diseases (Kalia and Gupta, 2006; Nwachukwu and Chukwu 2013; Sobukola *et al*., 2010; Ijabadeniyi, 2010). Regular intake of fruits and vegetables has been associated with low incidence of chronic diseases such as osteoporosis, cancer, chronic obstructive pulmonary and cardiovascular diseases. (Pem and Jeewon, 2015). Lerici *et al*. (2006) reported that nutritional and other benefits of a regular intake of vegetables and fruits are well documented internationally. In contrast to the health and economic benefits of fruits and vegetables, there is much concern about their contamination by human pathogens, after they have been consumed fresh, or moderately cooked (Iyoha and Agoreyo, 2015; Mahmoud, 2019). Production of vegetables is always a difficult task during dry season because of limited water availability. Consumption of fresh vegetables and fruits has increased mainly because of awareness of the benefits of a healthy diet and dry season vegetables has always met the fine need of consumer. However, limited attention have been paid to water quality used for irrigation of the vegetables produced in this period. There has been an increasing outbreak of food infection associated with the consumption of raw vegetables and fruits (Orji *et al*., 2016; Miraglia *et al*., 2009;

Liu *et al*., 2013). This research aimed to investigate the links between water quality and microbiological loads on fresh fruit and leafy vegetables.

Methodology

Experimental area: This study was carried out in Minna metropolis, Minna occupies a land area of about 6,784 square kilometers, which is a fraction of the entire Niger State, Nigeria; with a mean annual rainfall of 1300mm. Due to the all year-round high demand of vegetables and lack of appropriate storage facilities, irrigation is employed to enhance farming of vegetables during the dry season.

Laboratory preparation: Prior to sampling, necessary laboratory preparations were done. All glass wares materials used which include test tubes, syringe and needle (10 ml and 2 ml), vials, flasks, cylinder, conical flasks, glass plates were soaked in standard washing detergent overnight, thoroughly washed and sterilized by either dry heating at 160 °C for 2 hours or by autoclaving at 121°C for 15 minutes and later oven dried at 50 °C and stored at the same oven temperature. Similarly, disposable plastics went through autoclaving for sterilizing.

Sampling: Six different farms located within the Minna metropolis were considered for this study. Farm 1: El-Ameen Farms, Farm 2: Rural farm at Al-Bishri, Farm 3: Rural farm at Morris fertilizer area, Farm 4: Rural farm at Kangiwa Chanchaga, Farm 5: Rural farm near IBB Specialist Hospital Chanchaga and Farm 6: Upper River Basin and Development

From the farms, four leafy vegetables and four fruit vegetables were sampled in 3 replicates (Table 1 and Figure 1). Sterile polythene zip bags were used for sample collection, transported to the laboratory and processed within 6 hours with no significant temperature change. This is to maintain all necessary microbial analyses standards. The water being used for irrigation were also sampled from each of the farms. The samples collected were transported to the Department of Microbiology in the School of Life Sciences, Federal University of Technology, Bosso campus, Minna.

Figure 1: Picture representatives of the sampled vegetables.

Table 1: The sampled plants

English Name	Botanical Names	Farms sampled
Leafy vegetables		
Bitter-leaf	*Vernonia amygdalina*	Farm 1, Farm 2,
Fluted-pumpkin	*Telifairia occidentalis*	Farm 3
Spinach	*Amaranthus cruentus*	Farm 1, Farm 2
Water-leaf	*Talinum triangulare*	Farm 2, Farm 3
Fruit vegetables		
Bell-pepper	*Capsicum spp*	Farm 5, Farm 6
Chilli-pepper	*Capsicum annuum*	Farm 4, Farm 5
Okra	*Abelmoschus esculentus*	Farm 4, Farm 6
Tomatoes	*Solanum lycopersicum*	Farm 5, Farm 6

Microbial analyses

Media Preparation All media used were of analytical reagent grade. For the microbial analyses, two different media were considered; (1) Nutrient Agar (NA) for bacterial estimation and (2) Saboraud Dextrose Agar (SDA) for enumeration of fungal organisms. The methods of preparing the media are differently elucidated below.

Nutrient Agar (NA): 28 g of Nutrient Agar was suspended in a well prepared flask containing 1000 ml of cold distilled water. This was subjected to heat briefly to ensure that the medium was dissolved completely. It was afterwards sterilized by autoclaving. The medium was then poured into each prepared petri-dish and stored for further use. For assurance of sterility, the samples were incubated at 37°C overnight

Saboraud Dextrose Agar (SDA): 65 g of Saboraud Dextrose Agar was suspended in a prepared flask containing 1000 ml of cold distilled water, heated briefly for 1 minute to dissolve the medium completely. After dispensing and dissolving in distilled water, it was sterilized by autoclaving for 15 minutes at 15 lbs pressure (121 °C). It was afterwards cooled to about 45 – 50 °C and dispensed into each well-prepared petri-dishes and test tubes. The sterility was ensured and used under its refrigerated storage at 4 °C.

Preparation of the Diluent: Each sampled plant was crushed and thoroughly homogenised. The mortar and pestle used was carefully washed prior to each use and disinfected to avert any cross contamination. The homogenates were preserved in well labelled sterile bottles stored until needed. For each use, aliquots of the samples were serially diluted, each diluent of the buffered solution was afterwards inoculated on to its respective media. This procedure was observed in an aseptically order for both bacterial inoculation and the fungi inoculation. The pour plate count method was used for the total organism count (bacterial and fungi).

For the bacterial count, after pouring and allowing to solidify, they were incubated for 24 hours at 37 °C, while incubation for the fungi count was for 5 days at 28 ± 2 °C. The grown colonies counted were each expressed as colony forming units (cfu/ml) for the water samples and cfu/g for the vegetables. Repeated sub-culturing was employed to obtain pure cultures of isolates, the cultures were maintained on agar slants for further identification.

Characterization and Identification of Isolates: Bacterial and fungi isolates were characterized using microscopic appearance, colonial morphology and biochemical test. Identification of the isolates were confirmed in comparison to the known taxa.

Statistical tool: All obtained data were subjected to statistical Analysis of Variance (ANOVA) test using SPSS. Prevalence of both bacterial and fungal isolates were presented in descriptive statistics. For the cfu/g values obtained, statistical significance relations were tested between each sampled vegetable and the isolated pathogens.

Results

Differences in Bacteria and Fungi loads found in the water sample from the 6 farms

Bacterial count in the water sample: Results of the bacterial loads on water samples from the six considered farms within Minna metropolis are presented in Figure 2. The results show significant differences ($p<0.05$) among the means. Water samples from Farm 2 shows the highest bacterial load of 112.50×10^2 cfu/ml, followed by that of Farm 1 with 72.50×10^2cfu/ml and the water sample with the least bacterial load from Farm 6 with 5.00×10^2 cfu/ml.

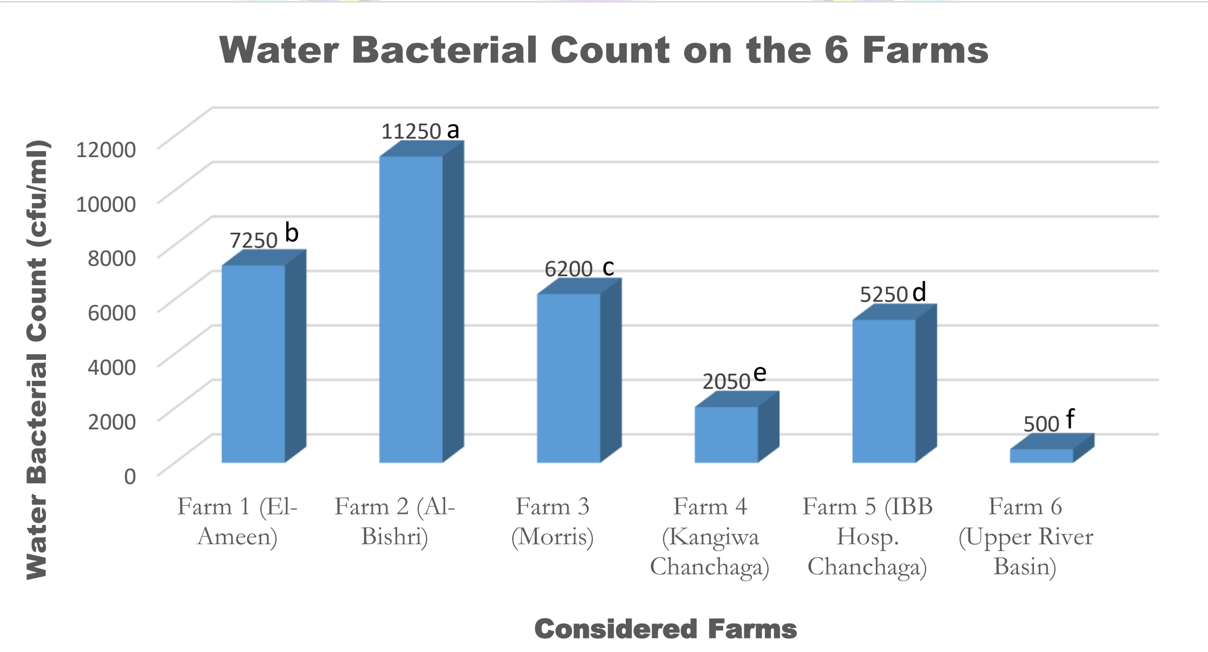

Figure 2: Differences in Bacteria load found in the water sample from the six farms

Fungi count in the water sample: The obtained results of the fungi load in water samples from the six considered farms in Minna metropolis are shown in Figure 3. Unlike the bacterial load results, there were no significance differences ($p<0.05$) in all water samples from the farms.

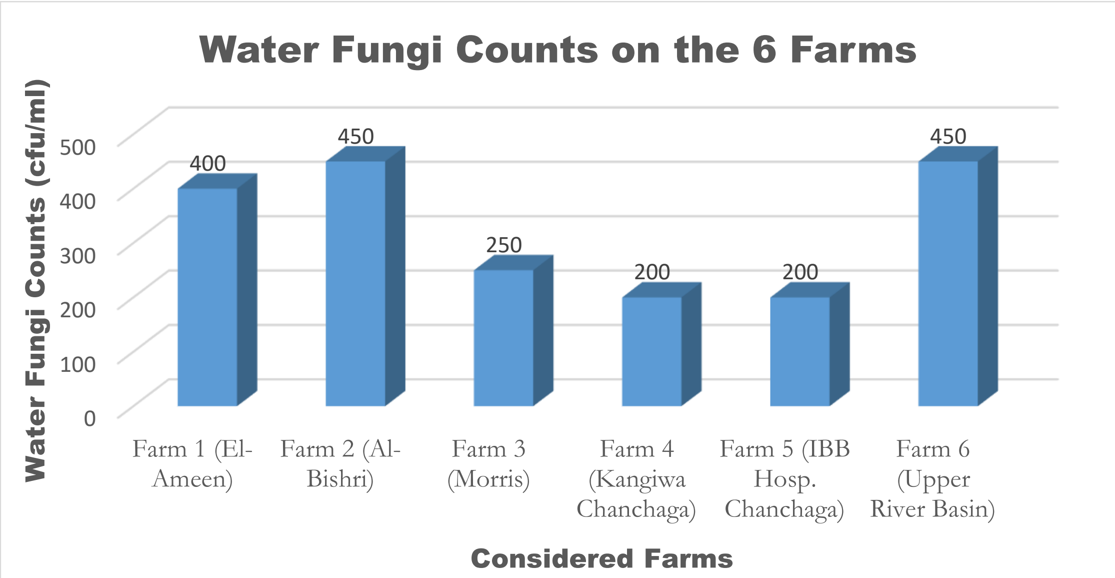

Figure 3: Differences in Fungi loads found in the water samples from the six farms

Differences in Bacterial &Fungi load found in leafy vegetables

As presented in Figure 4, the microbial load count for bacterial is higher than fungi count. For the bacterial count, the result shows significant differences among the means. Water leaf in farm 2 (Al-Bishri) has the highest bacteria count but was not significantly different from the bacterial count in spinach and bitter leaf on the same farm, as well as Spinach on Farm 1. On the other hand, Water-leaf on Farm 3 recorded the lowest bacteria count and significantly different from others except Bitter-leaf on Farm 1 and Fluted-pumpkin on Farm 3.

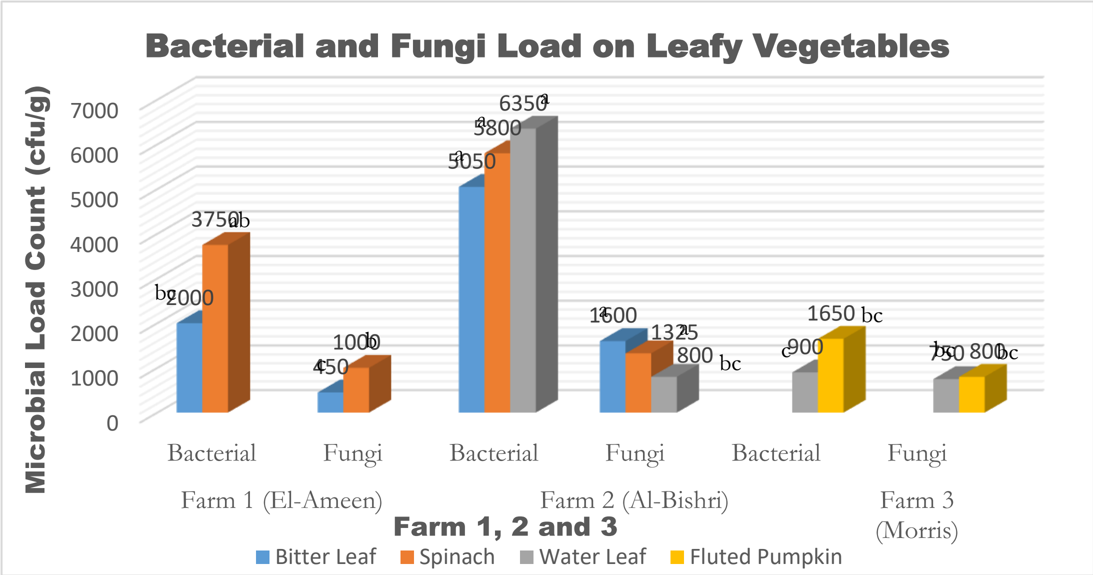

Figure 4: Differences in Bacteria and Fungi load found in leafy vegetables from Farm1 to 3

Differences in Bacteria and Fungi loads on Fruit Vegetables for Farm 4 to 6

The microbial load count for both bacterial and fungi found on sampled fruit vegetables are presented in Figure 5 below. Results obtained for the bacteria count showed significant difference ($p<0.05$) among the means. Chilli pepper on Farm 5 recorded the highest bacteria count and has no significant difference ($p<0.05$) from Tomato and Bell-pepper on the same farm. Similarly, the Bell-pepper from Farm 5 has no significant difference ($p<0.05$) from Bell-pepper and Tomato on Farm 6.

For the fungi load count, results obtained showed significant difference ($p<0.05$) among the means. Okra fruit on Farm 6 Okra and Chilli-pepper on Farm 5 recorded the highest fungi counts which shows no significant difference ($p<0.05$). However, Okra fruit on Farm 4 recorded the least fungi count but no significant difference ($p<0.05$) from Bell-pepper and Tomato fruits on the same farm 5. Contrary, it shows significant difference ($p<0.05$) from Chilli-pepper fruit on Farm 4.

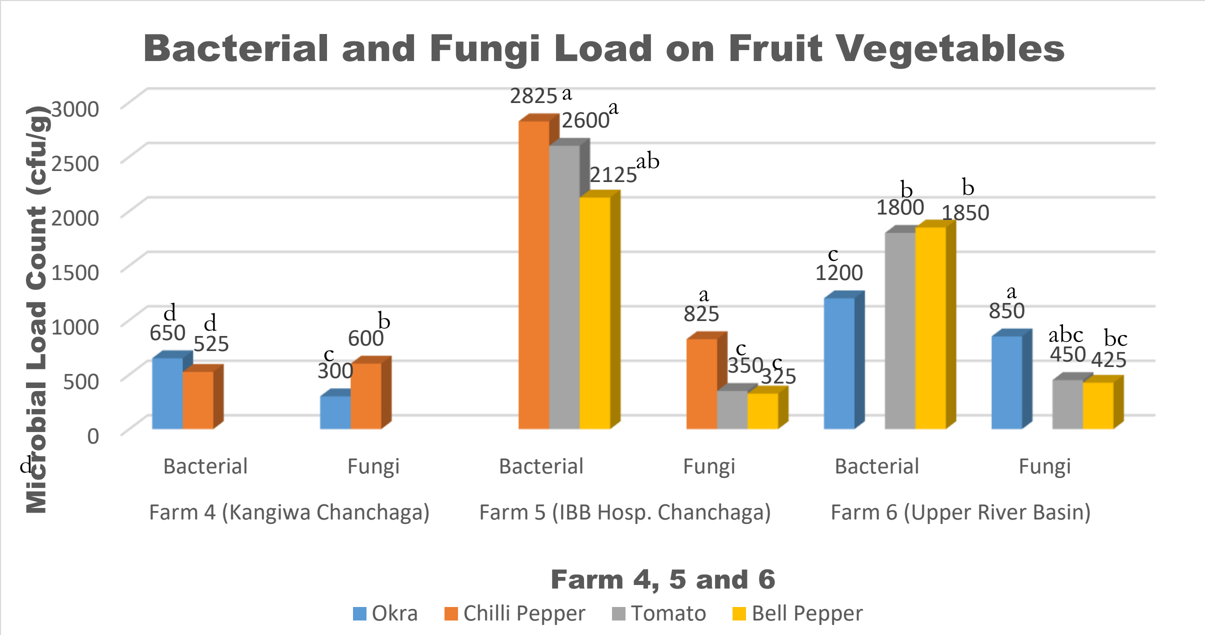

Figure 5: Differences in Bacteria load found on Fruit Vegetables from Farm 4 to Farm 6

Isolated Bacterial and Fungi

Bacterial organisms isolated from the water, leafy vegetables and fruit vegetables samples as presented in Table 2 belong to the genera *Escheria coli*, *Staphylococcus aureus*, *Bacillus substilis*, *Streptococcus feacalis and Staphylococcus epidermidis.* The isolated Fungal organisms, as presented in Table 3 include *Aspergillus niger*, *Aspergillus flavus*, *Saccharomyces cervicea*, *Penecillium species and Trychophyton specie.*

Table 2: Showing Bacteria Isolated from each of the farms.

Sampled area	***Escheria coli***	***Staphylococcus aureus***	***Bacillus substilis***	***Streptococcus feacalis***	***Staphylococcus epidermidis***
Farm 1	All samples	Bitter-leaf, Spinach	Bitter-leaf	-	-
Farm 2	Water	Water-leaf	Spinach	Water-leaf, Spinach	Bitter leaf
Farm 3	Water	Fluted-pumpkin	Water	-	-
Farm 4	Water	Okra	Okra	Water	Chilli-pepper
Farm 5	Water, Bell-pepper	-	Bell-pepper, Chilli-pepper	-	Tomato
Farm 6	Water, Tomato	Bell-pepper, Tomato	Tomato, Okra	Tomato	-

Table 3: Showing Fungi isolated from each of the farms.

Sampled area	***Aspergillus niger***	***Aspergillus flavus***	***Saccharomyces cervicea***	***Penecillium species***	***Trychophyton species***
Farm 1	Bitter-leaf, Spinach	Spinach	Water	Bitter-leaf	-
Farm 2	Spinach	-	Bitter-leaf, Water	Water-leaf, Bitter-leaf	-
Farm 3	-	Water-leaf	Fluted-pumpkin	-	Water-leaf
Farm 4	Chilli-pepper	Okra	Water	Okra	-
Farm 5	All samples	-	-	Tomato, Bell-pepper	Chilli-pepper
Farm 6	-	-	Water	Tomato	Okra, Chilli-pepper

Discussion

The results show that bacteria and fungi are present in the leafy vegetables, fruit vegetables, and the water used for irrigation in dry season in each of the sampled area in Minna metropolis. This corresponds with previous studies within this region (Tsado *et al*., 2013). However, the bacteria counts are more prominent in the water used for irrigation than the vegetables in all farms except Farm 6, which has bacteria count for irrigation water as low as 5×10^2 cfu/ml while the vegetables high count up to 12×10^2 (Okra), 18.5×10^2 (Tomato) and 18.5×10^2 (Bell pepper). It could also be observed that leafy vegetables have higher bacteria count than the fruit vegetables.

The high bacteria count on the water could be attributed to the source of water used for the irrigation. A related reason is the waste water some farms used to augment their irrigation water during dry season (Tsado *et al* 2013).

The fungi count in the irrigation water was observed to be lower than the fungi count found in the vegetables. It was also observed that leafy vegetables have greater fungi count than the fruit. Since the fungi count in the irrigation water is lower than the vegetables fungi count, it could be deduced that the higher fungi count on the vegetables could be due to the manure used for organic fertilizer or presence of soil borne pathogens or the hygiene level of the area where the vegetables were grown.

Conclusions

Microbial control is very essential in food crops, to prevent its related health hazards potentials. Vegetable samples obtained from all the considered farms show the presence of bacterial and fungi, which are within the standard satisfactory thresholds. The high bacterial count on the leafy counts is due to the high bacterial count from the irrigation water. This is vice versa compared to fungi with lower counts. It is recommend that all year production of vegetable within Minna Metropolis and the country at large. However, it should be under adequate management of the irrigation process. The farmers should ensure the use of quality, hygienic and standard satisfactory water in irrigating their farms. In addition, the final consumers of the vegetables should ensure adequate washing of their vegetables using water containing chlorine or very clean running water.

References

Ijabadeniyi, O. A. (2010.) *Effect of irrigation water quality on the microbial safety of fresh vegetables (Ph.D. thesis)*, Pretoria University of Agricultural and Food sciences, Johannesburg, South Africa,

Iyoha O, Agoreyo F. (2015) Bacterial contamination of ready to eat fruits sold in and around ugbowo campus of university of Benin (Uniben), Edo State, Nigeria. Br J Med Med Res. 2015;7:155-60. DOI:10.9734/bjmmr/2015/15356.

Kalia A, Gupta R.P (2006). Fruit Microbiology, in Hui Y.H, J.,Cano, M.P., Gusek, W., Sidhu, J.W., Sinha, N.K.Handbook of Fruit and Fruit processing. 1st Edition, Blackwell publishing, pp 3-28.

Lerici C. R, Nicoli M. C, and Anese M. "The weight" given to food processing at the "Food and Cancer Prevention III" symposium, *Italian Journal of Food Science*, vol. 12, no.1, pp.3-7, 2000.

Liu C., Hofstra N. & Franz, E. (2013). Impacts of climate change on the microbial safety of pre-harvest leafy green vegetables as indicated by Escherichia coli O157 and

Mahmoud B. Science-based recommendations for the production of safe fruits and vegetables in developing countries. Food Safety Magazines FSM eDigest, 2019. https://www.foodsafetymagazine.com/enewsletter/sciencebased-recommendations-for-the-production-of-safe-fruits-and-vegetables-in-developingcountries/. Accessed April 4, 2019.

Miraglia, M., Marvin, H.J.P., Kleter, G.A., Battilani, P., Brera, C., Coni, E., Cubadda, F., Croci, L., De Santis, B., Dekkers, S., Filippi, L., Hutjes, R.W.A., Noordam, M.Y., Pisante, M., Piva, G., Prandini, A., Toti, L., vanden Born, G.J. & Vespermann, A. (2009). Climate change and food safety: An emerging issue with special focus on Europe. *Food and Chemical Toxicology* 47(5), 1009-1021.

Nwachukwu E, Chukwu CM. Effect of chemical treatments on the microbial load of fruits and vegetables. IJAMBR. 2013;1:16-19.

Orji JO, Orinya C, Okonkwo E (2016), The microbial contamination of ready-to-eat vended fruits in Abakpa Main Market, Abakaliki, Ebonyi State, *Nigeria. J Pharm Biologic Sci. 2016;11:71-80.*

Pem D, Jeewon R. Fruit and Vegetable Intake: Benefits and progress of nutrition education interventions- narrative review article. Iran J Public Health. 2015;44:1309 21. PMID:26576343.

Sobukola OP, Adeniran OM, Odedairo AA. Heavy metal levels of some fruits and leafy vegetables from selected markets in Lagos, Nigeria. AJFST. 2010;4:389-93.

Tsado E. K., Adesina O. A. and Oyeleke S. B. "A Survey on the Bacterial Load of Selected Fruits and Leafy Vegetables in Minna Metropolis of Niger State, Nigeria". *J Anim Prod Adv*2013, 3(1):6-11

112 EFFECT OF DAYS AFTER ANTHESIS AND STORAGE PERIOD ON SEED QUALITY OF TWO OKRA (*Abelmoschus esculentus* L. Moench) VARIETIES

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Abstract

A laboratory experiment was conducted to determine the effect of days after anthesis on the quality of the okra seed. Lab Experiment consist of treatments with factorial combinations of two okra varieties (NHAe47-4 and LD 88), and seven fruit harvesting stages (14, 21, 28, 35, 42, 49 and 56 days after anthesis) arranged in a Completely Randomized Design (CRD) and replicated four times. Seed storage and germination percentage was determined. Data collected were subjected to analysis of variance (ANOVA) using SAS Statistical package 9.2. At 5% level of probability means were separated using Student- Newman Keuls (SNK) Test. Fruits of LD88 harvested at 42 days after anthesis had a better germination percentage than fruit of other harvesting day. With the result of this study, okra fruits should be harvested after 42DAA for better quality seeds.

Key words: Okra, Fruit and Days after anthesis

INTRODUCTION

Okra (*Abelmoschus esculentus* (L.) Moench) is a flowering plant in the Malvaceae family, commonly known by several names in different parts of the world. *Abelmoschus esculentus* and *Hibiscus esculentus* are the Latin binomial names for Okra (Kumar *et. al*, 2010). Okra is usually called "Kubewa" in Hausa, "Ila" in Yoruba and "okwuru" in Igbo speaking languages in Nigeria. Okra is also known as ladies' finger, reported to have originated from Ethiopia (Sathish and Eswar, 2013) and was then propagated in North Africa, in the Mediterranean, in Arabia and India by the 12th century BC (Tripathi *et al*., 2011).

Nitrogen is the second most absorbed nutrient by vegetables and plays a fundamental role in their yield (Souza *et al*., 2017). In addition, N considerably mobilizes the process of flower opening, fruit setting and fruit development. Seed development influences the seed performance (Bita and Maryam 2011). Seed maturation, however, is closely associated with fruit maturation and complete fruit drying (Ashok *et al.*, 2005). The stage of harvest of okra fruit has a significant influence on the quality of its seed. Delayed harvesting may lead to low germination and vigour due to adverse weather conditions in okra (Dias *et al*., 2006). Ibrahim and Oladiran, (2011) had also reported poor germination of early-harvested seeds which they attribute to the large proportion of immature seeds in the sets of seeds. The objectives of the study were to determine the effect of days after anthesis on seed quality of okra.

MATERIALS AND METHODS

The seed quality testing was carried out after the field work in the laboratory of the Department of Crop Production, Federal University of Technology, Minna, Niger State. Seeds of the two okra varieties (NHAe 47-4 and LD 88 were sourced from the National Horticultural Research Institute (NIHORT) Ibadan, Oyo State Nigeria.

The laboratory experiment consist of treatments of two okra varieties (NHAe47-4 and LD 88), and seven fruit harvesting stages (14, 21, 28, 35, 42, 49 and 56 days after anthesis) combined factorially and arranged in a Completely Randomized Design (CRD) and replicated four times.

Samples of seeds of each of the treatment combinations (variety x DAA) were put in small open plastic plates measuring 300 ml and then placed in an incubator at 35 °C and relative humidity of 90 %. This was aimed at accelerating the ageing of the seeds to determine the relative longevity of the seeds of the different lots (Delouche and Baskin, 1973). The okra seed samples were drawn from the containers in storage for conducting germination test at 0, 2, and 4 weeks after storage. This was done by counting four replicates of 30 seeds of the seven harvesting stages which was placed on filter paper moistened with distill water in plastic Petri-dishes. Germination counts was taken every-other-day and results were expressed in percentages. The data collected were subjected to analysis of variance (ANOVA) using SAS Statistical package 9.2. At 5% level of probability means were separated using Student- Newman Keuls (SNK) Test.

RESULTS

The results revealed a significant ($P \leq 0.05$) variations in viability between the two varieties used. At the onset and up to 4 weeks of storage, LD88 germinated significantly higher than NHAe47-4. Following storage for 4 weeks, germination values for the two varieties were similar. Prior to storage seed from fruit of NHAe47-4 has a lower (49.21%) germination percentage compared to two (2) week of storage which recorded (54.9%) but dropped to (33.00%) after (4) weeks in storage (Table 1). With respect to days after anthesis, there was significant effect on storage period prior to storage. At 14 days after anthesis, a significant increase in viability of seed was recorded down to (42) days after anthesis, which recorded the highest germination percentage (79.25%). It began to decline at forty-nine (49) days after anthesis (60.45%) and 56 days after anthesis (55.00%). This indicates that beyond 42 days after anthesis seed begin to lose its viability.

DISCUSSION

The decline in seed viability of okra varieties after a storage period of 42 as seen in this study is indicative of seed deterioration. This finding is in agreement with (Bewley and Black, 2012) who had reported a decline in seed viability and attributed it to disruption of cell organelles due to free radical production in the cells of embryos. Rao *et al.* (2017) reported that seeds should be harvested at the appropriate time to quality in terms of germinability and vigour. However, (Passam *et al.*, 2010) reported that fruits harvested even before physiological maturity and allowed some days of post-harvest ripening may produce good quality seeds since seed development continues in fleshy fruits owing to continuous supply of nutrients and food reserves from fruit to seed.

However, for okra seed production, fruits are left on the mother plant until they are dry before harvested. The seed crop requires the right stage of maturity followed by proper drying to ensure high germinability after harvest and storage. This is because seed longevity is known to be influenced by the initial seed quality, which is affected by the production procedure (Bortey and Dzomeku, 2016).

CONCLUSION

It can be concluded from this study that Fruits of LD88 harvested at 42 days after anthesis had a better germination. With the result of this study, okra fruits should be harvested after 42DAA for good quality seeds and stored for 2 weeks.

Table 1. Effect of harvesting at different days after anthesis on germination percentage of two okra varieties at storage period 0, 2, and 4 weeks.

Storage Period (Weeks)			
Week	**0**	**2**	**4**
Variety			
NHAe47-4	49.21^{b}	54.9^{ba}	33.00^{b}
LD88	66.16^{a}	58.09^{a}	36.53^{a}
$\pm$ SE	1.09	2.18	0.87
DAA			
14	30.90^{e}	38.90^{c}	25.75^{d}
21	48.25^{d}	48.65^{bc}	27.25^{d}
28	57.00^{c}	56.25^{b}	34.00^{c}
35	72.95^{b}	57.15^{b}	35.65^{cb}
42	79.25^{a}	75.45^{a}	52.80^{a}
49	60.45^{c}	61.35^{b}	39.90^{b}
56	55.00^{c}	57.90^{b}	28.00^{d}
$\pm$ SE	2.04	4.08	1.63
Interaction			
Variety*Anthesis	*	NS	NS

Means with the same alphabet in the same column are not significantly different at ($p \leq 0.05$) level of probability. SE = Standard Error, N: Nitrogen, Var: Variety, DAA: Days after anthesis.

REFERENCES

Ashok S. Sajjan, Shekargouda, M., Biradar, B.D., Pawar, K.N. & Devaranvadgi, S.B. (2005). Fruit development andseed maturation studies in Okra (*Ablemoschus esculentus* (L.) Moench.). *Indian Journal of Agricultural Res*earch, 39: 310-312.

Bewley, J. D., Bradford, K., & Hilhorst, H. (2012). Seeds: physiology of development, germination and dormancy. *Springer Science & Business Media*.

Bita O. & Maryam D. (2011). The effect of mother plant nitrogen on seed vigor and germination in rapeseed. ARPN *Journal of Agricultural and Biological Science*. (6) 5.

Bortey, H.M. & Dzomeku, B.M. (2016). Fruit and seed quality of okra [*Abelmoschus esculentus (L.) Moench*] as influenced by harvesting stage and drying method. CSIR-Crops Research Institute *Indian Journal of Agriculture Research*, 50 (4): 330-334.

Delouche, J. C., & Baskin, C. C. (1973). Accelerated ageing techniques for predicting the relative storability of seed lots. *Seed Science and Technology*. 1: 427-452.

Passam, H. C., Theodoropoulou, S., Karanissa, T., & Karapanos, I. C. (2010). Influence of harvest time and after-ripening on the seed quality of eggplant. *Horticultural Science*. 125(3): 518-520.

Rao, N. K., Dulloo, M. E., & Engels, J. M. (2017). A review of factors that influence the production of quality seed for long-term conservation in gene banks. *Genetic Resources and Crop Evolution*. 64(5): 1061-1074.

Sathish, D., & Eswar, A. (2013). A Review on: *Abelmoschus esculentus* (Okra). *International Research Journal of Pharmaceutical Applied Science*. 3(4): 129-132.

Souza, Á. H. C., Rezende, R., Lorenzoni, M. Z., Seron, C. C., Hachmann, T. L., & Lozano, C. S. (2017). Response of eggplant crop fertigated with doses of nitrogen and potassium. Revista Brasileira deEngenharia Agrícola e Ambiental. 21, (1): 21-26.

Tripathi K. K, Govila OP, Warrier R, & Ahuja V. (2011). Biology of Abelmoschus esculentus L. (Okra). Series of Crop Specific Biology Documents (35p.), Department of Biotechnology, Ministry of Science & Technology, & Ministry of Environment and Forest, Govt. of India.

113 ASSESSMENT OF SELECTED SOIL FERTILITY PARAMETERS ALONG A TOPOSEQUENCE UNDER INTENSIVE CROP PRODUCTION AND IMPLICATIONS FOR SUSTAINABLE MANAGEMENT

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ABSTRACT

This study assessed the effect of topography on distribution and status of soil organic carbon (SOC), total nitrogen (N), available phosphorus (P) and potassium (K) in soil under intensive crop production in Minna, Niger State. The farm selected for the study was partitioned along major slope direction into upper, middle and lower slope positions. In each physiographic unit, three soil samples were randomly collected at 0-25 cm depth, making a total of nine samples. The samples were analyzed in the soil science laboratory of Federal University of Technology Minna for particle size distribution, SOC, N, P and K. Data obtained was subjected to one-way analysis of variance (ANOVA) to test the effect of topography on the distribution of the selected soil fertility parameters. Results revealed that loamy sand for the upper and middle slopes and sandy loam texture for the lower slope. Topography had no significant effect on the distribution of N, while significant effect ($P<0.05$) was observed with regards to SOC, P and K. Fertility assessment revealed that low status in SOC ($\leqslant 3.74$ g kg^{-1}) and K ($\leqslant 0.08$cmol kg^{-1}) and moderate to high P (15.50 – 21.75 mg kg^{-1}) and high N ($\geqslant 1.47$ g kg^{-1}). Phosphorus showed a regular distribution trend (upper>middle>lower slope), a reversed order for SOC (upper<middle<lower slope), and irregular trends in N and K. No significant correlation among the parameters assessed. Productivity and sustainability of the soil, irrespective of slope positions, may require K amendment to satisfy the nutrient requirement for most crop production.
Keywords: Toposequence, soil fertility, crops, smallholder farm.

INTRODUCTION

Topography influences redistribution of soil properties through its effect on drainage, soil erosion, transportation and deposition of soil materials (Isola *et al*., 2020). These processes explain why major changes in soil type occur over very short distance as one moves from crest position down to the valley bottom (Egbuchua, 2014; Rezaei *et al*., 2015), even when the soils are developed from the same parent materials (Esu *et al.*, 2008; Lawal *et al*., 2014). Several studies on the effect of topography on soil properties across all ecological zones of Nigeria have been adequately reported (Osodeke and Osondu, 2006; Lawal *et al.*, 2014; Jimoh *et al*., 2020). However, such studies were generic with little or no attention to specific crops.

MATERIALS AND METHODS

Description of the Study Site

The study site is within Gidan Kwano campus of the Federal University of Technology, Minna, approximately 16 km along Minna-Bida road in Niger State of Nigeria. The site is geographically located on latitude 09º 32′ 14.356″ N and longitude 06º 27′ 53.418″ E on average elevation of 202 m above mean sea level. The climate of the environment is sub-humid tropical with mean annual rainfall of about 1283 mm and relative humidity ranging from 33 to 87 %. The mean maximum daily temperature reaches peak at 40 ºC during February to March (Adeboye *et al*., 2011). The site is underlain by igneous and metamorphic rocks of the pre-Cambrian Basement Complex with granites, gneisses, migmatites, quartzites and schists which weathered to form Ferric Luvisols, Ferric Acrisols and Ferric Cambisols (Ojanuga, 2006). Vegetation of the area is southern Guinea savanna of Nigeria. Tubers (yam) and cereals (maize, sorghum, upland rice) and legumes (groundnut, cowpea and soybean) are major crops grown in the area.

Soil sample collection

An age long smallholder farm under intensive crop cultivation was selected for the study. Slope direction was used as a guide to divide the farm into three slope positions, namely: the upper, middle and lower slope. Each slope position served as a treatment, under which three soil samples were randomly collected at 0-25 cm depth. Thus, nine (9) soil samples were collected for laboratory analysis.

Sample preparation and analysis

The air-dried samples were carefully crushed to break the lumps and then passed through a 2 mm mesh to separate fine and coarse fragments. The sieved soil samples were analyzed for particle size distribution and some chemical properties according to standard laboratory procedures as outlined in IITA (2015). Briefly, particle size distributions of the soil samples were determined using the Bouyocous hydrometer method with sodium hexametaphosphate as dispersing agent. The textural classes of the soils were determined using IUSS soil Textural Triangle. Organic carbon was determined by Walkley-Black method of wet combustion involving oxidation of organic matter with potassium dichromate ($K_2Cr_2O_7$) and sulphuric acid (H_2SO_4). Total nitrogen (N) was determined by micro Kjeldahl method and available phosphorus (P) by Bray P-1 method. Exchangeable potassium (K) was extracted with 1N neutral ammonium acetate (NH_4OAc) saturation method and amount of K in solution was measured using a Flame Photometer.

Data analysis

Data from laboratory was subjected to analysis of variance (ANOVA) using SPSS version 20. Where significant differences were observed, means were separated using Least Significant Difference (LSD) at 0.05 level of probability (Gomez and Gomez, 1984). Correlation analysis was carried out to establish the relationship among the selected soil chemical properties.

RESULTS AND DISCUSSION

Effect of Topography on Particle size distribution

Results of the particle size distribution of the soil investigated are presented in Figure 1a,b&c. Sand fraction ranged from 784 to 886 g kg^{-1}, silt from 37 to 86 g kg^{-1} and clay from 77 to 130 g kg^{-1}. These soil separates did not show any particular trend in their distribution probably due to prolong human activities through tillage which overshadowed the influence of topography in their distribution. Also, sand content was observed as dominant mineral fraction in the studied soil irrespective of slope positions. The preponderance of sand could be in one part linked to the inherent nature of parent rocks, rich in quartz mineral. This result agrees with the findings of Alhassan *et al*. (2012) which identified quartz as the most dominant mineral in the soils in several locations in Minna. Quartz is resistant to weathering (Wilson, 2010); hence, it accumulates on the surface where sorting processes of finer soil materials (silt and clay) by agents of erosion such as wind and run-off (Akinbola *et al*., 2009; Imadojemu *et al.*, 2017; Isola *et al*., 2020) are active. This probably explained why the surface textures of the soils investigated were loamy sand to sandy loam.

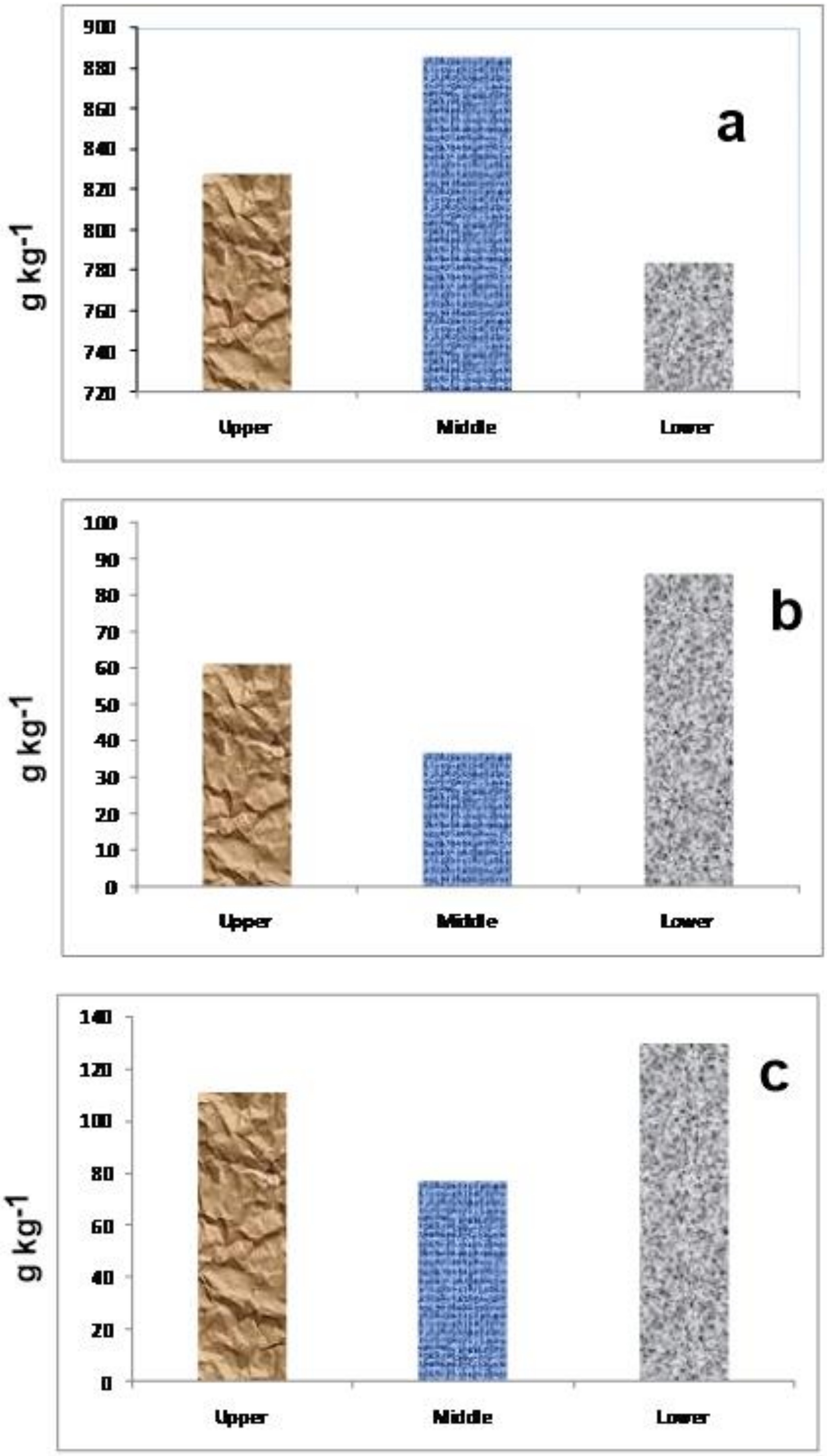

Figure 1abc: Distribution of sand (a), silt (b) and clay (c) in the upper, middle and lower slope positions of the study site

Effect of topography on selected soil fertility parameters

Results on the effect of topography on the distribution of soil organic carbon (SOC), total nitrogen (N), available phosphorus (P) and potassium (K) are presented in Table 1.The correlations among the soil qualities parameters assessed are presented in Table 2. Fertility interpretation followed the fertility ratings of Esu (1991) for the Nigeria's arable soils. The effect of topography on the distribution of SOC was significant table 1.The concentration of SOC in lower slope (3.74 g kg^{-1}) was significantly higher ($P<0.05$) than the upper slope (2.37 g kg^{-1}) by a factor of 1.58, while the SOC concentration in the middle slope was statistically similar to both upper and middle slope positions. The trend of SOC distribution was regular in the following increasing order upper<middle<lower down the slope. There was no significant correlation between SOC and other parameters assessed. However, the distribution pattern observed in the current study was similar to the findings by Akinbol *et al*., 2009) which also indicated significantly larger amount of SOC, about 1.38 to 1.44 times higher, at the toe slope positions than those at the shoulders along the top sequences investigated.

Table 1: Selected Soil fertility parameters as affected by topographic positions

Slope position	SOC	N	P	K
	(g kg^{-1})		(mg kg^{-1})	(cmol kg^{-1})
Upper	2.37b	1.54a	21.75a	0.05b
Middle	3.14ab	1.47a	20.00b	0.08a
Lower	3.74a	1.79a	15.50c	0.04c
LSD (0.05)	0.84	8.4	4.2	0.0008

Means followed by same letter(s) in column are not significantly different ($P < 0.05$).

In terms of fertility ranking, SOC was very low in the soil, irrespective of slope positions. Reasons for low SOC in these soils could be linked to intensive use of the land coupled with poor management practices by farmers such as burning of vegetation/crop residues which minimized the recycling to enrich the soils. Farmers in the area in recent time resort to burning of crop residues, as a way of wading off encroachment of their farms by herders.

Table 2: Correlation matrix among the soil fertility parameters in topographic positions

	SOC	N	P	K
SOC	1			
N	0.08NS	1		
P	-0.40 NS	-0.05 NS	1	
K	0.32 NS	-0.29 NS	0.39 NS	1

*NS = Correlation not significant at 0.05 level (2-tailed).

There was no significant effect of topography on the distribution of total N in the soil. However, numerically, the lower slope had the highest N content while the middle slope had the lowest in table 1 above. Irrespective of slope positions, the status of N in the soils was high. This was contrary to previous studies which reported very low to low N in similar soils (Lawal*et al*., 2014; Adeboye*et al*., 2020).

Further investigation also revealed a non-significant ($P>0.05$) correlation between N and SOC (r^2 = 0.08) probably due to the very low concentration of the latter in the soil. However, studies have shown a direct relationship between SOC and total N content suggesting, an increase in soil organic carbon content will result in an increase in total nitrogen content (Brevik*et al*., 2010). Since the current study revealed a non-significant correlation between SOC and N, it suggests that the high total N status in these soils could be as a result of repeated application of N-rich fertilizers by the farmers within the area. This argument is supported by a report of Wibowo and Kasno (2021) which traced the sources of N added to agricultural soils to be majorly through inorganic fertilizer and partly through other sources such as biological fixation, precipitation, gas adsorption and organic fertilizers (manure, green manure and crop residues).

The effect of topography on the distribution of available P was significant ($P<0.05$) in the soil. Upper slope had the highest P concentration (21.75 mg kg^{-1}) and lower slope had the lowest (15.50 mg kg^{-1}). Also, a regular distribution trend of increasing order, (upper>middle>lower slope), was observed. However, there was no significant correlation between P and other parameters assessed. The status of P in the soil was moderate to high as against low values (≤ 9 mg kg^{-1}) it was reported by Lawal*et al*. (2021) for similar soils under intensive use close to the current study site. High P status in the soils investigated may be attributed to use of mineral fertilizers by the farmers which resulted to accumulation of the nutrient in the soil. Accumulation of P may have implication in the farming environment. According to Van *et al*. (2017), excessive use of P fertilizers in intensive agricultural systems leads to P accumulation in soil. Notwithstanding, the soils investigated may not show P deficiency for crop production in the nearest future if well managed.

A significant ($P<0.05$) effect of topography on K distribution was observed despite its low status in the soil. The middle slope had the highest (0.08 cmol kg^{-1}) concentration while the lower slope had the lowest (0.04 cmol kg^{-1}). The status of K in the soils investigated was low irrespective of slope positions and no definite trend in its distribution. Also, there was no significant correlation of K with other chemical properties assessed. Previous investigations on similar soils reported higher values (≥0.11cmol kg^{-1}) of K (Afolabi *et al*., 2014; Lawal *et al*., 2014; Lawal *et al*., 2021). Thus, low status of K recorded in the current study was slightly lower than the average reported for savanna soils (Diby *et al*., 2011), and could be explained in terms of intensity and duration of weathering, leaching and erosion (Sanchez, 1976; O'Sullivan, 2010). Another reason may be associated to intensive use of the land for crop production and poor nutrient management by the farmers, resulting to nutrient mining, more so that the crop is known to be a high-nutrient- feeders. (Carsky *et al*., 2007).

CONCLUSION

The study revealed a non-significant effect of topography on distribution and status of total nitrogen (N) in the soils investigated. Topography had a significant influence on the distribution of soil organic carbon (SOC), available phosphorus (P) and potassium (K) based on the results, management of SOC, P and K should be slope position-specific intensive use of the land has degraded the soil as it manifest low SOC. Recycling of crop residues and application of manure are recommended to improve soil organic matter. Potassium was the only nutrient deficient in the soil and can be amended through application of K-rich fertilizers such as muriate of potash in order to satisfy high K demand by some crops such as yam for tuber formation. High concentration of N and P in the soils should be monitored closely as further application could result in economic wastage and or may cause environmental pollution from run-off.

REFERENCES

Adeboye, M.K.A., Afolabi, S.G., Lawal, B.A. and Mamman, I.B. (2020). Nitrogen Use Efficiency of Maize as Affected by Zinc Fertilization in the Moist Savanna of Nigeria. *Nigerian Journal of Soil and Environmental Research*, 19: 22–31.

Adeboye, M.K.A., Bala, A., Osunde, A.O., Uzoma, A.O., Odofin, A.J. and Lawal, B.A. (2011). Assessment of soil quality using soil organic carbon and total nitrogen and microbial properties in tropical agroecosystems. *Agricultural Sciences*. 2(1): 34-40.

Afolabi, S.G., Adeboye, M.K.A., Lawal, B.A., Adekanmbi, A.A., Yusuf, A.A. and Tsado, P.A. (2014). Evaluation of some soils of Minna southern Guinea savanna of Nigeria for arable crop production. *Nigerian Journal of Agriculture*, *Food and Environment*, 10(4): 6-9.

Akinbola, G.E., Anozie, H.I. and Obi, J.C. (2009). Classification and characterization of some pedons on basement complex in the Forest Environment of South-Western Nigeria. *Nigerian Journal of Soil Science*, 19(1):109-117.

Alhassan, M., Mesaiyete, E. and Mustapha, A.M. (2012). Clay mineralogy of lateritic soils derived from granite basement- A case study of Minna lateritic soils. *Journal of Geotechnical Engineering*, 17: 1897-1903.

Brevik, E., Homburg, J. and Sandor, J.(2018). Soil Knowledge and Management:in *Early Civilizations,*Horwath, W.R. and Kuzyakov, Y.(eds.). Developments in Soil Science Climate Change Impactson Soil Processes and Ecosystem Properties, Elsevier, pp 7–12.

Carsky, R.J., Wolo, N., Manyong, V.M. and Tian, G. (2007). Nutritional balance model for design of sustainable production in yam cropping systems, in (M. O. Akoroda and J.M. Ngeve, Eds.): *Proceedings of the 7th Triennial Symposium of the International Society for Tropical Root and Tuber Crops—Africa Branch*, IITA, Cotonou, Benin.pp. 198–209.

Diby, L.N., Tie, B.T., Girardin, O., Sangakkara, R. and Frossard, E. (2011). Growth and Nutrient Use Efficiencies of Yams (Dioscorea spp.) Grown in Two Contrasting Soils of West Africa. *International Journal of Agronomy*,2011: 1-8. doi:10.1155/2011/175958.

Egbuchua, C.N. (2014). Morphological and Physical Characteristics of Soils Developed on a Toposequence Derived from Coarse-grained Pegmatites in a Tropical Region, Delta State, Nigeria. *Asian Journal of Agriculture and Rural Development*, 4(5):313-323.

Esu, I.E. (1991). Detailed Soil Survey of NIHORT Farm at Bunkure, Kano State, Nigeria. Institute for Agricultural Research, Ahmadu Bello University, Zaria, Nigeria. 72pp.

Esu, I.E., Akpan-Idiok A. U., Eyong M.O. (2008). Characterization and classification of soils along a typical Hillslope in Afikpo Area of Ebonyi State, Nigeria. *Nigerian Journal of Soil and Environment*, 8:1-6.

Gumez, K.A. and Gumez, A.A. (1984). *Statistical Procedures for Agricultural Research*. Second edition, John Wiley Sons, New York. 680 p.

IITA (2015). Selected Methods for Soil and Plant Analysis. Manual Series N0.3, IITA Ibadan, Nigeria. 126pp.

Isola, J. O., Asunlegan O. A., Abiodun, F. O. and Smart, M. O. (2020). Effect of soil depth and topography on physical and chemical properties of soil along Federal College of Forestry, Ibadan North West, Oyo State. *Journal of Research in Forestry*, *Wildlife & Environment*.12(2): 383–390.

Jimoh, A.I., Mbaya, A.L., Akande, D., Agaku, D.T. and Haruna, S. (2020). Impact of toposequence on soil properties and classification in Zaria, Kaduna State, Northern Guinea Savanna, Nigeria. *International Journal of Environmental Quality*, 38: 48-58.

Konnovora M.M., Mowakowski, T.Z., Newmann, A.C.D. (1966). *Soil organic matter, its nature, its roles in soil formation and soil fertility*. Pergamon Press, New York.

Lawal, B.A., Adeboye, M.K.A., Tsado, P.A., Mohammed, T. and Panti, A.A. (2021). Spatial variability and fertility mapping for site-specific management of a smallholder farm in Minna, Nigeria. *Asian Journal of Research and Review in Agriculture*, *3(4): 50-56*.

Lawal, B.A., Tsado, P.A., Eze, P.C., Idefoh, K.K., Zaki, A.A. and Kolawole, S. (2014). Effect of slope positions on some properties of soils under a *Tectonagrandis* plantation in Minna, southern Guinea savanna of Nigeria. *International Journal of Research in Agriculture and Forestry*, 1(2): 37-43.

O'Sullivan, J.N. (2010). Yam Nutrition: Nutrient Disorders and Soil Fertility Management. ACIAR Monograph No. 144. Australian Centre for International Agricultural Research: Canberra. 112 pp.

Ojanuga, A.G. (2006). Agroecological Zones of Nigeria Manual. FAO/NSPFS, Federal Ministry of Agriculture and Rural Development, Abuja, Nigeria, 124pp.

Osodeke, V.E. and Osondu, N.E. (2006). Phosphorus distribution along a toposequence of coastal plain sand parent material in southeastern Nigeria. *Agricultural Journal*, 1(3): 167-171.

Rezaei, H., Jafarzadeh, A. A., Alijanpour, A., Shahbazi, F., Kamran, K. V. (2015). Effect of Slope Position on Soil Properties and Types along an Elevation Gradient of Arasbaran Forest, Iran. *International Journal on Advanced Science Engineering and Information Technology*, 5(6):449-456.

Van, D.S.C., Van Middelkoop, J.C. and Ehlert, P.A.I. (2017). Changes in soil phosphorus poolsof grasslands following 17years of balanced application of manure and fertilizer. *Soil Use and Management*, 33: 2–12.

Wibowo, H. and Kasno, A. (2021). Soil organic carbon and total nitrogen dynamics in paddy soilson the Java Island, Indonesia. 1st International Conference on Sustainable Tropical Land Management. IOP Conference Series: *Earth and Environmental Science* 648 (012192): 1-9. doi:10.1088/1755-1315/648/1/012192.

114 EFFECT OF DAYS AFTER ANTHESIS AND STORAGE PERIOD ON SEED QUALITY OF TWO OKRA (*Abelmoschus esculentus* L. Moench) VARIETIES

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Abstract

A laboratory experiment was conducted to determine the effect of days after anthesis on the quality of the okra seed. Lab Experiment consist of treatments with factorial combinations of two okra varieties (NHAe47-4 and LD 88), and seven fruit harvesting stages (14, 21, 28, 35, 42, 49 and 56 days after anthesis) arranged in a Completely Randomized Design (CRD) and replicated four times. Seed storage and germination percentage was determined. Data collected were subjected to analysis of variance (ANOVA) using SAS Statistical package 9.2. At 5% level of probability means were separated using Student- Newman Keuls (SNK) Test. Fruits of LD88 harvested at 42 days after anthesis had a better germination percentage than fruit of other harvesting day. With the result of this study~~,~~ okra fruits should be harvested after 42DAA for better quality seeds.

Key words: Okra, Fruit and Days after anthesis

INTRODUCTION

Okra (*Abelmoschus esculentus* (L.) Moench) is a flowering plant in the Malvaceae family, commonly known by several names in different parts of the world. *Abelmoschus esculentus* and *Hibiscus esculentus* are the Latin binomial names for Okra (Kumar *et. al*, 2010). Okra is usually called "Kubewa" in Hausa, "Ila" in Yoruba and "okwuru" in Igbo speaking languages in Nigeria. Okra is also known as ladies' finger, reported to have originated from Ethiopia (Sathish and Eswar, 2013) and was then propagated in North Africa, in the Mediterranean, in Arabia and India by the 12th century BC (Tripathi *et al*., 2011).

Nitrogen is the second most absorbed nutrient by vegetables and plays a fundamental role in their yield (Souza *et al*., 2017). In addition, N considerably mobilizes the process of flower opening, fruit setting and fruit development. Seed development influences the seed performance (Bita and Maryam 2011). Seed maturation, however, is closely associated with fruit maturation and complete fruit drying (Ashok *et al.*, 2005). The stage of harvest of okra fruit has a significant influence on the quality of its seed. Delayed harvesting may lead to low germination and vigour due to adverse weather conditions in okra (Dias *et al*., 2006). Ibrahim and Oladiran, (2011) had also reported poor germination of early-harvested seeds which they attribute to the large proportion of immature seeds in the sets of seeds. The objectives of the study were to determine the effect of days after anthesis on seed quality of okra.

MATERIALS AND METHODS

The seed quality testing was carried out after the field work in the laboratory of the Department of Crop Production, Federal University of Technology, Minna, Niger State. Seeds of the two okra varieties (NHAe 47-4 and LD 88 were sourced from the National Horticultural Research Institute (NIHORT) Ibadan, Oyo State Nigeria.

The laboratory experiment consist of treatments of two okra varieties (NHAe47-4 and LD 88), and seven fruit harvesting stages (14, 21, 28, 35, 42, 49 and 56 days after anthesis) combined factorially and arranged in a Completely Randomized Design (CRD) and replicated four times.

Samples of seeds of each of the treatment combinations (variety x DAA) were put in small open plastic plates measuring 300 ml and then placed in an incubator at 35 $^{\circ}$C and relative humidity of 90 %. This was aimed at accelerating the ageing of the seeds to determine the relative longevity of the seeds of the different lots (Delouche and Baskin, 1973). The okra seed samples were drawn from the containers in storage for conducting germination test at 0, 2, and 4 weeks after storage. This was done by counting four replicates of 30 seeds of the seven harvesting stages which was placed on filter paper moistened with distill water in plastic Petri-dishes. Germination counts was taken every-other-day and results were expressed in percentages. The data collected were subjected to analysis of variance (ANOVA) using SAS Statistical package 9.2. At 5% level of probability means were separated using Student- Newman Keuls (SNK) Test.

RESULTS

The results revealed a significant ($P \leq 0.05$) variations in viability between the two varieties used. At the onset and up to 4 weeks of storage, LD88 germinated significantly higher than NHAe47-4. Following storage for 4 weeks, germination values for the two varieties were similar. Prior to storage seed from fruit of NHAe47-4 has a lower (49.21%) germination percentage compared to two (2) week of storage which recorded (54.9%) but dropped to (33.00%) after (4) weeks in storage (Table 1). With respect to days after anthesis, there was significant effect on storage period prior to storage. At 14 days after anthesis, a significant increase in viability of seed was recorded down to (42) days after anthesis, which recorded the highest germination percentage (79.25%). It began to decline at forty-nine (49) days after anthesis (60.45%) and 56 days after anthesis (55.00%). This indicates that beyond 42 days after anthesis seed begin to lose its viability.

DISCUSSION

The decline in seed viability of okra varieties after a storage period of 42 as seen in this study is indicative of seed deterioration. This finding is in agreement with (Bewley and Black, 2012) who had reported a decline in seed viability and attributed it to disruption of cell organelles due to free radical production in the cells of embryos. Rao *et al.* (2017) reported that seeds should be harvested at the appropriate time to quality in terms of germinability and vigour. However, (Passam *et al.*, 2010) reported that fruits harvested even before physiological maturity and allowed some days of post-harvest ripening may produce good quality seeds since seed development continues in fleshy fruits owing to continuous supply of nutrients and food reserves from fruit to seed.

However, for okra seed production, fruits are left on the mother plant until they are dry before harvested. The seed crop requires the right stage of maturity followed by proper drying to ensure high germinability after harvest and storage. This is because seed longevity is known to be influenced by the initial seed quality, which is affected by the production procedure (Bortey and Dzomeku, 2016).

CONCLUSION

It can be concluded from this study that Fruits of LD88 harvested at 42 days after anthesis had a better germination. With the result of this study, okra fruits should be harvested after 42DAA for good quality seeds and stored for 2 weeks.

Table 1. Effect of harvesting at different days after anthesis on germination percentage of two okra varieties at storage period 0, 2, and 4 weeks.

		Storage Period (Weeks)	
Variety	**Week** **0**	**2**	**4**
NHAe47-4	49.21^{b}	54.9^{ba}	33.00^{b}
LD88	66.16^{a}	58.09^{a}	36.53^{a}
+ SE	1.09	2.18	0.87
DAA			
14	30.90^{e}	38.90^{c}	25.75^{d}
21	48.25^{d}	48.65^{bc}	27.25^{d}
28	57.00^{c}	56.25^{b}	34.00^{c}
35	72.95^{b}	57.15^{b}	35.65^{cb}
42	79.25^{a}	75.45^{a}	52.80^{a}
49	60.45^{c}	61.35^{b}	39.90^{b}
56	55.00^{c}	57.90^{b}	28.00^{d}
+ SE	2.04	4.08	1.63
Interaction			
Variety*Anthesis	*	NS	NS

References

Ashok S. Sajjan, Shekargouda, M., Biradar, B.D., Pawar, K.N. & Devaranvadgi, S.B. (2005). Fruit development and seed maturation studies in Okra (*Ablemoschus esculentus* (L.) Moench.). *Indian Journal of Agricultural Res*earch, 39: 310-312.

Bewley, J. D., Bradford, K., & Hilhorst, H. (2012). Seeds: physiology of development, germination and dormancy. *Springer Science & Business Media*.

Bita O. & Maryam D. (2011). The effect of mother plant nitrogen on seed vigor and germination in rapeseed. ARPN *Journal of Agricultural and Biological Science*. (6) 5.

Bortey, H.M. & Dzomeku, B.M. (2016). Fruit and seed quality of okra [*Abelmoschus esculentus (L.) Moench*] as influenced by harvesting stage and drying method. CSIR-Crops Research Institute *Indian Journal of Agriculture Research*, 50 (4): 330-334.

Delouche, J. C., & Baskin, C. C. (1973). Accelerated ageing techniques for predicting the relative storability of seed lots. *Seed Science and Technology*. 1: 427-452.

Passam, H. C., Theodoropoulou, S., Karanissa, T., & Karapanos, I. C. (2010). Influence of harvest time and after-ripening on the seed quality of eggplant. *Horticultural Science*. 125(3): 518-520.

Rao, N. K., Dulloo, M. E., & Engels, J. M. (2017). A review of factors that influence the production of quality seed for long-term conservation in gene banks. *Genetic Resources and Crop Evolution*. 64(5): 1061-1074.

Sathish, D., & Eswar, A. (2013). A Review on: *Abelmoschus esculentus* (Okra). *International Research Journal of Pharmaceutical Applied Science*. 3(4): 129-132.

Souza, Á. H. C., Rezende, R., Lorenzoni, M. Z., Seron, C. C., Hachmann, T. L., & Lozano, C. S. (2017). Response of eggplant crop fertigated with doses of nitrogen and potassium. Revista Brasileira deEngenharia Agrícola e Ambiental. 21, (1): 21-26.

Tripathi K. K, Govila OP, Warrier R, & Ahuja V. (2011). Biology of Abelmoschus esculentus L. (Okra). Series of Crop Specific Biology Documents (35p.), Department of Biotechnology, Ministry of Science & Technology, & Ministry of Environment and Forest, Govt. of India.

SOIL SCIENCE / ENVIRONMENTAL MANAGEMENT

115 EFFECT OF BIOCHAR AND NANOPARTICLES ON THE MICROBIAL DEGRADATION OF CRUDE OIL CONTAMINATED SOIL

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Abstract

Oil spill in the Niger Delta region of Nigeria had caused substantial problems to the inhabitants of this region such as pollution of surface water, ground water, farmland and human health. The aim of this research is to study the effects of biochar, nanoparticles and microbial organism in remediating a crude oil contaminated soil. Analysis such as ash content, volatile matter, fixed carbon, thermo gravimetric analysis, organic carbon, nitrogen and synthesis of Nanoparticles were carried out during this study. Materials such as mortar and pistol, oven, thermogravimetric analyzer, pyrolizer, centrifuge, desiccator, incubator, miller and glass wares were used. Result shows that, the biomass had high volatile matter and low ash content in the proximate analysis while ultimate analysis showed high carbon and oxygen composition but low nitrogen and Sulphur contents, the amount of crude oil remaining in the treated sample was about 8.9% while the control sample was around 81%, this decrease in the control sample can be attributed to natural attenuation through the action of existing indigenous microorganisms.

Keywords: Biochar, Pyrolysis, Nanoparticles, Proximate analysis, Ultimate analysis.

INTRODUCTION

Crude oil is a yellowish-black viscous liquid that ensues naturally in geological formations under the earth's surface and is composed of hydrocarbon deposits and other organic materials. A type of fossil fuel, crude oil is refined to produce usable products including gasoline, diesel, and various other forms of petrochemicals (James, 2021). Crude oil was initially discovered in profitable amount in the Niger Delta region of Nigeria at Oloibiri (present day Bayelsa state) in 1956, more discoveries were made in other locations after that of Oloibiri and exploitation began almost 2years after the initial discovery. Soil pollution refers to the presence of a chemical or substance out of place and/ or present at a higher-than-normal concentration that has adverse effects on any non-targeted organism (FAO and ITPS, 2015). Although the majority of pollutants have anthropogenic origins, some contaminants can occur naturally in soils as components of minerals and can be toxic at high concentrations. Soil pollution often cannot be directly assessed or visually perceived, making it a hidden danger. Biological remediation uses microorganisms to degrade hazardous substances or complex organic contaminants into less toxic or non-toxic compounds (Li, 2007).

Groundnut or peanut is notably called “poor man’s nut” (Ansari *et al.*,2015). Today, it is an important oilseed and food crop globally (FAOSTA, 2018). This plant is one of the most popular crops in Nigeria and has never been found uncultivated. Groundnut shells have about 20% of the dried peanut pod by weight, that is, there is a significant amount of shell residual left over after groundnut processing (Zheng *et al.*,2013). Petroleum hydrocarbon are products of crude oil which are commonly used by humans for many purposes such as heating, power generation and transportation (Snape *et al.*,2001; Aislabie *et al.*,2006). Widespread pollution from petroleum hydrocarbon can be due to infrastructure failure, human fault, or natural cause (Snape *et al.*,2008). This raises an alarm on both local and global scale as petroleum hydrocarbon can have tremendous adverse effects on human and ecological health. Petroleum hydrocarbons are naturally occurring substance; hence, microorganisms which are capable of remediating these hydrocarbon compounds are in existence in the environment.

Biochar is a soil amendment which appeared in recent years as a great option which can act both as a carbon sink and as an amendment improving soil quality, increasing water retaining capacity, and fertility, thus eliminating risks for soil contamination (IPPC, 2019). Biochar production is achieved via a thermochemical process known as pyrolysis. Pyrolysis is termed as the thermal decomposition of biomass at elevated temperature (200^0C-1000^0C) under very low concentration of oxygen or no oxygen at all, and accompanied by the production of three by-products: biochar (solid), bio-oil (liquid) and syngas (Gibbins-matham *et al.*,1998). Pyrolysis consists of a large family of processes and reactor technologies. Heating rates and temperature characterize different types of pyrolysis, which yield different mixtures of the three products (Patel *et al.*,2016; Tripathi *et al.*,2016). Report by (Brennan *et al.*,2014) shows that biochar could alter the physical and chemical properties of soil. For instance (Mukherjee *et al.*,2014; Schmidt *et al.*,2014) found that biochar produced from Oak could increase the soil pH, improve the water holding capacity of the soil (Yao *et al.*,2012; Evangelou *et al.*,2014), increase the fertility of the soil (Steinbeiss *et al.*,2009; Mia *et al.*,2014), decrease leaching of soluble macro nutrients (Quilliam *et al.*,2013; Lucchini *et al.*,2014), and heighten carbon sequestration (Mendez *et al.*,2012; Bastos *et al.*,2014). Nano composites are high performance materials which reveal rare properties. Nanocomposites have an estimated annual growth rate of 25% and fastest demand to be in engineering plastics and elastomers (Sajad *et al.*,2019). Nanoparticles are a wide class of materials which include particulate substances. Nano particles have very large surface area which makes them more efficient to bind with various molecules.

In the last few decades, nano particles have been developed for treatment of soil and wastewater.

MATERIALS AND METHODS

The equipment used in this research work are; Mortar and Pistol, Oven, Thermogravimetric analyser, Pyrolyser, Centrifuge, Desiccator, GC-MS Analyzer, Incubator, Miller, Glass wares (beakers, testubes, measuring cylinder, crucibles, Petri dishes and syringes), and Calorimeter, Other materials include groundnut shell, crude oil and flavonoid extract.

Sample Collection and Preparation

Soil sampling site is located at Federal University of Technology Bosso Campus, Minna (9°32'5"N, 6°26'25"E, At-2ft). It was sieved using a mesh in order to remove the unwanted particles such as sticks and stones.

Method

Soil samples of 300g each were weighed in six different plates of same sizes. 30ml of crude oil was added to each of the samples to contaminate them and the set up were labeled A, B, C, D, E and Control as shown in Table 1.

Table 1: Experimental Design

Sample	*Biochar (g)*	*Pseudomonas (ml)*	*Nano Particle (g)*
A	10	30	0.2
B	20	60	0.4
C	30	90	0.6
D	40	120	0.8
E	50	150	1.0
Control	-	-	-

NB: all samples contain 30ml of crude oil in 300g of soil.

Streaking method was used in order to isolate the microorganisms and kept in an incubator for culturing. Steps followed in order to degrade the crude oil contained in the soil are highlighted in Fig.1 below.

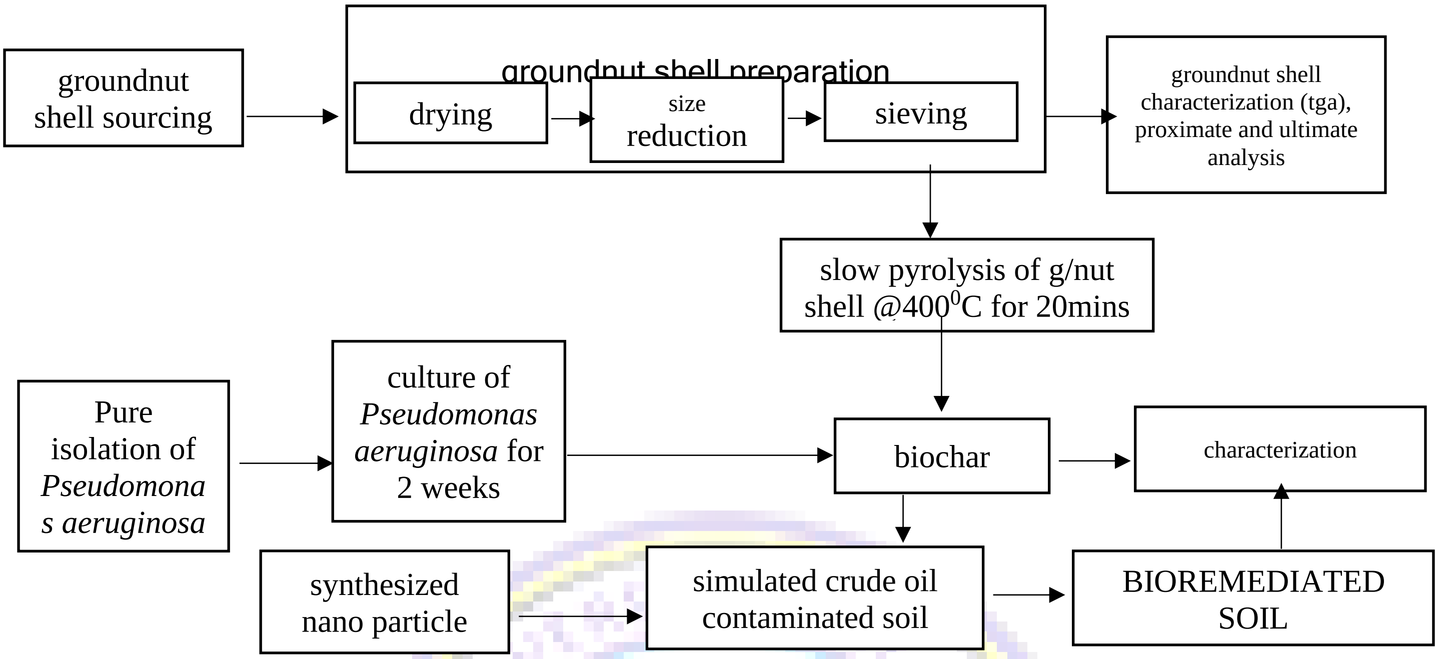

Fig. 1: Block diagram showing steps involved in degradation of crude contaminated soil.

Result and Discussion

The proximate analysis of the biomass showed high volatile matter and low ash content as shown in Table 2. While the ultimate analysis results showed high carbon and oxygen composition, but low nitrogen and Sulphur contents as shown below.

Table 2: Proximate and Ultimate Analysis of Groundnut Shell (Biomass)

Proximate Analysis		Ultimate Analysis	
Element	Composition (wt%)	Element	Composition(wt%)
Ash content	2.5	Carbon	50.98
Moisture content	8.5	Hydrogen	7.13
Fixed carbon	11.2	Nitrogen	0.59
Volatile matter	77.8	Oxygen	40.10
		Sulphur	0.22

The soil contaminated with crude oil showed some changes in the physical and chemical properties as shown in Table 3. The decrease in the values of pH and nitrogen in the contaminated soil is attributed to the introduction of crude oil, while the increase in the phosphorus and organic carbon is also due to the same reason. Furthermore, it can be seen from Table 3 that the soil treatment with biochar, microorganisms and nanoparticles altered the properties in a desirable way.

Table 3: Properties of the Soil After Seven Weeks of Treatment

Properties	Uncontaminated soil	Contaminated soil	Treated soil (with GB+N+P)	Control after 7 weeks
pH	6.43	5.7	6.38	5.97
Nitrogen(g/kg)	0.10	0.06	0.07	0.05
Phosphorus(mg/kg)	1.06	2.0	1.15	2.05
Organic Carbon(g/kg)	2.4	4.4	2.92	4.21

*GB- Groundnut shell Biochar *N- Nano particle *P- Pseudomonas

At the end of this research, the amount of crude oil left in the soil samples are shown in Fig. 2. Sample E had the lowest crude oil concentration after 7 weeks of treatment which can be ascribed to the high concentration of amendments in it, while the control sample had very little reduction in crude oil concentration due to it not having any amendments.

The hydrocarbon utilizing bacteria population increased rapidly after two weeks of amendment in all samples except for samples A and Control which can be attributed to the low concentration of amendment in sample A and lack of amendments in Control. Subsequently, there was a decline in the microbial count until there were no bacteria present in week five for samples D and E, and week six for samples B and C. Sample A had its highest bacteria population after 4 weeks of treatment. While the Control sample showed no significant increase in hydrocarbon utilizing bacteria throughout the treatment period of seven weeks as seen in Fig 3.

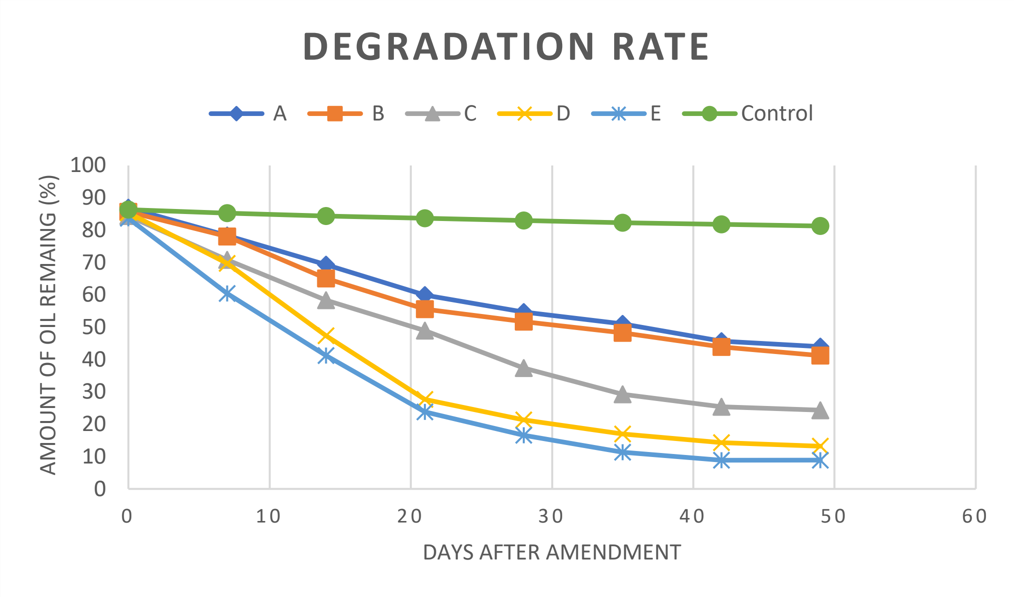

Fig. 2: Rate of Degradation of Crude Oil

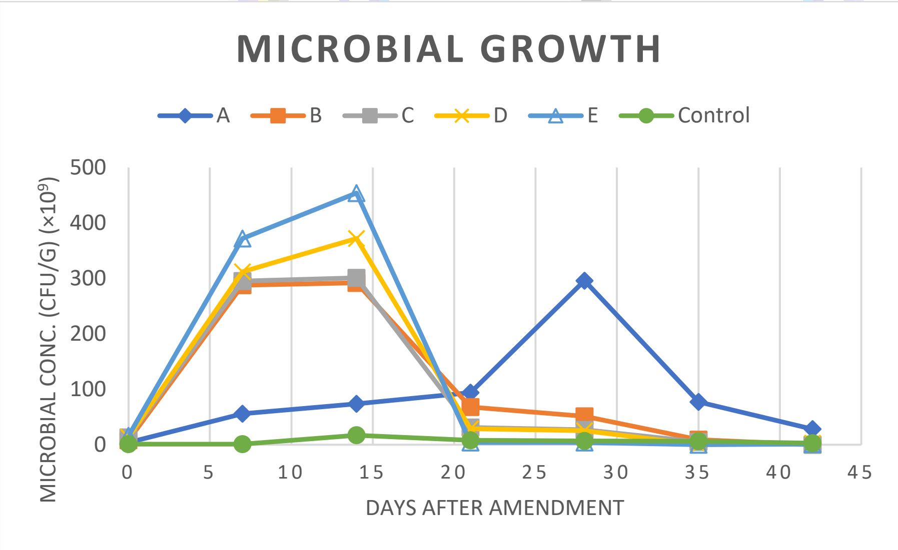

Fig. 3: Population of Microorganisms during Amendment.

CONCLUSION

The present study reports the use of biochar combined with nano particles and pseudomonas aeruginosa exhibited tremendous impact in degradation of crude oil in contaminated soil. However, concentration of soil amendments plays a vital role in the degradation rate and time. Higher concentration of the three amendments enhanced degradation faster compared to lower concentration of amendments in contaminated soil.

It is therefore recommended that, the application of these three soil amendments combined in the bioremediation of crude oil contaminated soil should be conducted in the field at a larger scale to check its effectiveness.

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References

Aislabie, J., D.J. Saul, and J.M. Foght. (2006). Bioremediation of hydrocarbon-contaminated polar soils. Extremophiles 10(3): 171–179.

Brennan A., Jiménez E.M., Alburquerque J.A., Knapp C.W., Switzer C. (2014). Effects of biochar and activated carbon amendment on maize growth and the uptake and measured availability of polycyclic aromatic hydrocarbons (PAHs) and potentially toxic elements (PTEs). Environ Pollut 193:79–87.

Gibbins-Matham J., Kandiyoti R. (1998). Coal Pyrolysis yields from fast and slow heating in a wire-mesh apparatus with gas sweep. Energy & Fuels; 2:505-511

James Chen. (2021). Guide to Investing in Oil Markets, available at www.investopedia.com/terms/c/crude-oil.asp.

Lucchini P., Quilliam R.S., DeLuca T.H., Vamerali T., Jones D.L. (2014) Increased bioavailability of metals in two contrasting agricultural soils treated with waste wood-derived biochar and ash. Environ Sci. Pollut Res 21(5):3230–3240.

Mia S., van Groenigen J.W., Van de Voorde T.F.J., Oram N.J., Bezemer T.M., Mommer L., Jeffery S. (2014) Biochar application rate affects biological nitrogen fixation in red clover conditional on potassium availability. Agric Ecosyst Environ 191:83–91.

Schmidt H.P., Kammann C., Niggli C., Evangelou M.W., Mackie K.A., Abiven S. (2014) Biochar and biochar-compost as soil amendments to a vineyard soil: influences on plant growth, nutrient uptake, plant health and grape quality. Agric Ecosyst Environ 191:117–123.

Snape I., Morris C.E., and Cole C.M. (2001). The use of permeable reactive barriers to control contaminant dispersal during site remediation in Antarctica. Cold Reg. Sci. Technol. 32(2–3): 157–174.

Snape, I., Acomb L., Barnes D.L., Bainbridge R., Eno R., Filler D.M., Plato N., Poland J.S., Raymond T.C., Rayner J.L., Riddle M.J., Rike A.G., Rutter A., Schafer A.N., Siciliano S.D., and Walworth J.L. (2008). Contamination, regulation, and remediation: An introduction to bioremediation of petroleum hydrocarbons in cold regions. p. 1–37. In Filler, D.M., Barnes, D.L., Snape, I. (eds.), Bioremediation of Petroleum Hydrocarbons in Cold Regions. Cambridge University Press, Cambridge.

Tripathi, M.; Sahu, J.N.; Ganesan, P. (2016) Effect of process parameters on production of biochar from biomass waste through pyrolysis: A review. Renew. Sustain. Energy Rev. 2016, 55, 467–481.

Yao Y., Gao B., Zhang M., Inyang M., Zimmerman A.R. (2012) Effect of biochar amendment on sorption and leaching of nitrate, ammonium, and phosphate in a sandy soil. Chemosphere 89(11):1467–1471.

Zheng W., Guo M., Chow T., Bennett D.N., Rajagopala N. (2010). Sorption properties of greenwaste biochar for two triazine pesticides. Journal of hazardous materials 181, 121–126.

116 INDIGENOUS KNOWLEDGE AND COPING CAPACITY OF FARMERS FOR CLIMATE CHANGE ADAPTATION: A CASE STUDY OF AGAIE LOCAL GOVERNMENT AREA, NIGER STATE. NIGERIA

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Abstract

Globally, climate change is one of the most severe environmental threats facing humans. Climate change has adversely affected agricultural productivity in Nigeria. This paper is part of a study that examined how indigenous knowledge system (IKS) of climate change plays a role in adjusting to the changing climate in Agaie LGA of Niger State, Nigeria. Structured questionnaire was administered to 314 farmers selected amongst the communities in the study area. The study concluded that prolonged dry periods and unusually early rains cause uncertainties in onset of farming season. These consequences of climate change are linked to 'reduced yields and income', which are being fueled by 'burning of wood fuel', 'bush burning' and 'use of fertilizers. Therefore, this study has shown that local communities have a good understanding of climate variability and change; there is a need to incorporate this understanding into climate interpretation, so as to increase the application of indigenous knowledge for climate change adaptation.

KEYWORDS: Climate change, coping strategies, Indigenous Knowledge, Adaptation

1.0 Introduction

Climatic change is attributable to natural climate cycle and human activities (Ziervogel *et al.*, 2006); as the planet warms, rainfall patterns shift, and extreme events such as droughts, floods, and forest fires become more frequent. It is projected that crop yield in Africa may decline by 10-20% by 2050 or even up to 50% due to climate change (Jones and Thornton, 2003). This is because African agriculture is predominantly rain-fed and hence fundamentally dependent on the vagaries of weather. Wisner *et al.* (2004) reports that the vulnerability of agriculture is determined by both the nature and magnitude of environmental stress like climate change and the societal capacity to cope with and/or recover from environmental change. This study is an attempt to collate sustainable indigenous knowledge on climate change adaptation practices in Agaie LGA of Niger State.

2.0 Review of Related Literature

Adaptation to global warming is a response to climate change that seeks to reduce the vulnerability of social and biological systems to climate change effects (Head, 2010). The capacity and potential for humans to adapt (called adaptive capacity) is unevenly distributed across different regions and populations, and adaptive capacity is closely linked to social and economic development (Adger *et al.*, 2005). Adaptation can be categorized into two: building adaptive capacity (by increasing the abilities of groups, individuals or organizations to adapt to changes), and implementing adaptation decisions (by transforming that capacity into action). Over the years, local people have used their knowledge and practices to adjust to changing economic, ecological, and social circumstances (Anik and Khan, 2012), thus helping communities to minimize disaster risks and formulate cost-effective and participatory adaptation measures (Nakashima *et al.*, 2012).

3.0 Methodology

This study was conducted in Agaie town, which is the headquarter of Agaie Local Government Area of Niger State. It lies between latitude90 00′ 3060 N and longitude 6019′ 556 E. Agaie is located in a low basin within the valley of River Gbakogi. The mean annual rainfall of the study area is 1227 mm^3 and mean monthly temperature of 27°C - 35°C. The predominant tribe is Nupe; the indigenous habitants are mostly Muslims, farmers, and fishermen. The socio-economic status and literacy level is low. Infrastructural facilities present in the town include a government owned general hospital, and erratic electricity and pipe-borne water supply.

The study employed field observation through focus group discussions and semi - structured questionnaire administered to 314 farmers selected amongst the wards of the study area to collect primary data. The perception of local communities is important to have a better understanding of the scientific basis of their indigenous knowledge. The data collected was analyzed through the use of percentages and Mean Item Score (MIS); the results were presented in bar charts.

4.0 Results and Discussion

4.1 Socioeconomic characteristics of respondents

The majority (86%) of the respondents were male, while 14% were female. About three quarters of the sample (74%) were between the economically active age range of 30 – 59 years; within the study area, farming does not appear to have been left to the very old. Majority of the respondents (56%) had primary education, 30% had secondary education, and 14% had tertiary education. Crop farming is the principal activity of 71% of the respondents.

4.2Climate change impact on agriculture

Results in Figure 1 revealed that majority (97%) of the respondents agreed that heavy winds, drought and decrease in soil moisture have been increasingly experienced in the study area. As shown in Figure 1, Mean Item Scores of more than 3.49 indicate agreement by the respondents.

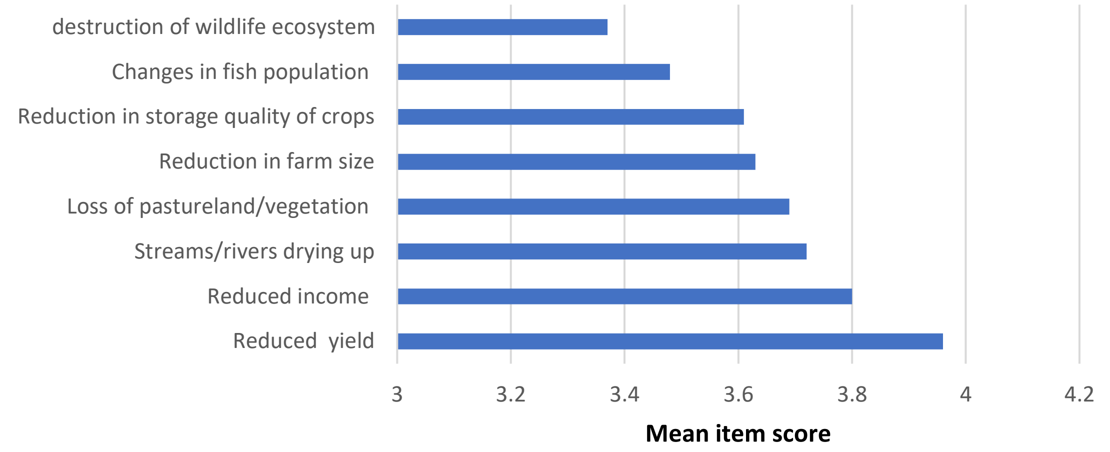

Figure 1: Climate change impact on agriculture

Based on the magnitude of the Mean Item Scores, it was observed that the respondents ranked 'reduced yield' 1st in terms of climate change impact on agriculture; 'reduced income' was ranked 2nd while 'streams/rivers drying up' was ranked 3rd. This is line with Otitoju (2013). Mark *et al.* (2008) observed that features of climate change could impact agro-climatic conditions, altering growing seasons, planting, and harvesting calendars, water availability, pest, weed and disease populations.

Activities of farmers that contribute to climate change

The respondents ranked 'burning of wood fuel' 1st in terms of contributing to climate change. 'Bush burning' was ranked 2nd while 'use of fertilizers' was ranked 3rd. The high cost of alternative energy such as cooking gas and kerosene and the poverty level of farmers in the study area makes burning of wood fuel as cooking energy a major practice (Mohammed, 2018). Bush burning as the 2nd ranked activity is as a result of the traditional practice of clearing farmland for farming activity, which increases the concentration of greenhouse gases in the atmosphere. Also, majority of the farmers (91%) had reported decrease in soil fertility with consequent increase in fertilizer application).

Conclusion and Recommendations

The study concluded that local communities have a deep understanding of climate variability and change, hinged on increase in temperature, and erratic and delayed rainfall. Prolonged dry periods and unusually early rains cause uncertainties in onset of farming season. These consequences of climate change are linked to 'reduced yields and income', which are being fuelled by 'burning of wood fuel', 'bush burning' and 'use of fertilizers.

This study recommended that since farmers in Agaie have some perception of the effects of their activities on climate change, the following actions can be taken:

i. Programmes that educate and enlighten farmers in Agaie LGA on climate change coping strategies should be frequently organized so that activities of farmers that contribute to the impact of climate change can be avoided.

ii. Indigenous coping strategies and best practices from other communities both within and outside Nigeria should be incorporated for better results.

REFERENCES

Anik, S. I. & Khan, M. A. S. A. (2012). Climate change adaptation through local knowledge in thenorth eastern region of Bangladesh.*Mitigation and Adaptation Strategies for Global Change*, 17(8),879-896.

Head, L. (2010). Cultural Ecology: Adaptation-Retrofitting A Concept? In *Progress in Human Geography* 34 (2), pp. 234–242.

Jones, P.G. & Thornton, P.K. (2003). *Croppers to livestock keepers: Livelihood transition to 2010 in Africa due to climate change.* Geneva, Switzerland: Global Environmental Change, World Health Organization.

Mark, W. R. E., Mandy, Y., Gary, B., Lan, H., Saleem, U. L.&Rowena, V.S. (2008). *Climate change and agriculture: Threats and opportunities.*Bonn, Germany: Federal Ministry for Economic Cooperation and Development.

Mohammed, S. (2018). Use of Wood Energy in Relation to Deforestation in Wushishi LGA, Niger State, Nigeria. Assumption University-eJournal of Interdisciplinary Research (AU-eJIR), 4(1), ……….

Nakashima, D. J., McLean, K. G., Thulstrup, H., Castillo, A. R. & Rubis, J. T. (2012). *Weathering uncertainty: traditional knowledge for climate change assessment and adaptation.* Paris and Darwin: UNESCO and UNU.

Otitoju, M. A. (2013). The effects of climate change adaptation strategies on food crop production efficiency in Southwestern Nigeria. Unpublished PhD thesis submitted to Department of Agricultural Economics, University of Nigeria, Nsukka.

Wisner, B., Blaikie, P., Cannon, T.&Davis, I. (2004). *At risk: natural hazards; people's vulnerability and disasters* (2nd ed.). London: Routledge.

Ziervogel G., A. Nyong, B. Osman, C. Conde, S. Cortes, and T. Dowing 2006 Climate variability and change: implications for household food security. Assessments of Impacts and Adaptations to Climate Change (AIACC) Working Paper No. 20, January 2006. The AIACC Project Office, International START Secretariat, Washington DC, USA.

117 ASSESSMENT OF FERTILITY STATUS OF SOME SELECTED FADAMA SOILS IN BIDA LOCAL GOVERNMENT AREA OF NIGER STATE, NIGERIA

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Abstract

Declined in soil fertility have capitulated decreased in food production. This study outlines the role of Fadama soils as an answer to sustainable crop production and increase in yield. The study was conducted to evaluate the fertility status of some selected Fadama soils in Bida L.G.A of Niger state, Nigeria. Five (5) locations of Fadama soils (Fadama) were selected around Bida metropolis, namely Banyagi, Nasarafu, Daracita, Film-Ta and Bangaie. Twenty (20) representative Fadama soil samples were collected randomly from a depth of 0-20 cm from two (2) farms at each of the locations, bulked together to form a composite sample for each of the location. The samples were subjected to laboratory analysis using standard procedures. The data obtained were subjected to simple descriptive statistics including coefficient of variation (CV) to test for dispersion of the data. Results obtained show that the soils were mostly sandy loams in texture. The pH, total nitrogen, Organic carbon, Calcium, K and CEC were very low. Magnesium and sodium varied from medium to high. Percentage base saturation was medium. The incorporation of crop residues, application of organic manure and split application of inorganic fertilizers to the soils will play an important role in nutrient availability of these soils for sustainable crop production in the study area.

Keywords: *Assessment, fertility potentials, Fadama soils, sustainable crop production, Bida.*

INTRODUCTION

Nigeria is characterized by chronic food deficit caused by fast population growth rate and slowest pace of food production (Onyekwere, 2013). The slow rate of production is attributable to many factors among which are soil factors, vagaries of weather, notably unavailability and uneven monthly distribution of rain fall (Farmer and Wigley, 1985). Over four million hectares of land scattered along the river systems of Nigeria have been identified as Fadama area, capable of supporting intensive cultivation and grazing. Fadama ecosystem has potential for all season agricultural production (Lawal *et al*., 2012).

Recently, much attention has been given to Fadama lands in Nigeria due to the rapid increase in population and the need to feed the ever increasing human and animal population (Shefiu, 2007). Factors limiting the agricultural development in Nigeria include lack of much information on soils physico-chemical characteristics (Kparmwang, 1996). The Fadama farm in Bida over the years has mainly been used for rice, vegetable and sugar cane production under rain fed condition and irrigation systems. Therefore, the aim of this study is to evaluate the soil physico-chemical properties of Fadama soils in Bida metropolis.

MATERIALS AND METHODS

Study Areas, Soil sampling and Laboratory analysis

The study area was Bida, a major town in Niger state, Nigeria. The area lies between Latitude: 9º.06′N and Longitude 6º.01′E with an elevation of 150 m above sea level. Bida lies within the basement complex and the Nupe Sand stone formation. Five (5) locations of Fadama soils were selected around Bida metropolis, namely Banyagi, Nasarafu, Daracita, Film-Ta and Bangaie. Twenty (20) representative Fadama soil samples were collected randomly from a depth of 0-20 cm from two (2) farms at each of the locations, bulked together to form a composite sample for each of the location. The soil samples were air-dried, ground and passed through a 2-mm sieve to obtain the fine earth fractions for determination of physical and chemical soil properties following standard laboratory procedures. Particle size analysis was determined by Bouyoucos hydrometer method. The pH was determined using 1:2.5 soil water ratio. Total nitrogen and available phosphorus was determined by the macro-kjeldahl digestion and Bray-1 method. The Soil Organic carbon was analysed using the Walkley-Black procedure. Exchangeable bases, calcium (Ca), magnesium (Mg), potassium (K) and sodium (Na) were extracted with 1N NH4OAC. Calcium and Mg in the extract was determined using atomic absorption spectrophotometer (AAS) while K and Na were determined by flame photometry.

Results and Discussions

Physical and Chemical Properties of Soils of the study area.

The results of particle size fractions of surface depth (0-20cm) are presented in Table-1. The result of the study showed that the fadama soils around Bida metropolis are majorly sandy loam to sandy clay loam in nature with average sand content of 60.56% and a CV of 10.04%. The silt and clay content has a CV of 0.22 and 0.30%. The soils were low in both clay and silt with average values of 15.65% and 23.79%, respectively. Sand content across all the sampling sites ranged between 52.80% and 71.20%, silt content ranged between 18.4% and 31.10% while clay content ranged between 10% and 20.60%. This results is similar to the findings of Alarima *et al*., (2018) of soils of bida and neighbouring areas been sandy loam.

Soil reaction was strongly acidic to moderately acidic with pH values ranging from 4.57 to 5.48 (Table 1). The pH was low in all locations with average values of 5.08 (strongly acidic). The low CV (6.26%) shows that the soils around bida metropolis are uniformly acidic. The pH of the study soils may imply high level of leaching of non acid cations. The low pH may affect availability of other essential plant nutrient (Lawal *et al*., 2014). The available P content of the soils was the low ranging from 4.35 - 9.41 mg kg^{-1} with a mean value of 6.20 mg kg^{-1} and a

CV of 26.89%. This result corroborates with the findings of Onyekwere (2013) for Fadama soils in Barikin Sale, minna. The low P content of soils of the study area is attributed to the generally low total P in savannah soils and the interaction of P and soil constituents (Manu *et al*., 1995) and due to low phosphate potentials of the parent rock (Raji *et al.*, 2001). The N content was generally low ranges from 0.12-0.51 gkg^{-1} with a mean value of 0.40 g kg^{-1}. The low N contents may be as a result of impeded nitrogen mineralization under anaerobic condition, which does not pass the ammonia stage and lost as a gas to the atmosphere (Brady and Weil, 2008). The low amount of total Nitrogen in the soils is a reflection of the organic carbon content in the soils (Onyekwere *et al*., 2009), since inorganic N is accounting for only a small portion of total N in Savanna soils (Almu and Audu 2001). This results is agrees with the findings of Alarima *et al*., (2018) for soils of similar locations in Bida and Adamu *et al*., (2019) for Fadama soils in Sumaila, Kano state. The organic carbon of the soil at all locations is low with a mean value of 3.18gkg^{-1}(low). The low organic carbon content in all the assessed soils could be attributed to the low natural organic matter returns and other human factors such as burning and removal of crop residue (Ahmed, 1995). This could be further attributed to rapid mineralization of the organic matter by micro organism which is active throughout the year as a result of the prevailing high temperature and low amount of clay fraction of the soil (Raji *et al.*, 2001). The O.C contents in soils were not uniform with a CV of 37.16%. Calcium ranged between 1.27 to 2.61 cmol kg^{-1} with an average value of 1.83 cmol kg^{-1} (low) and Mg ranged between 0.35 to 1.01 $cmolkg^{-1}$ with an average value of 1.83 cmol kg^{-1} (medium). The low value of exchangeable Ca and medium value of Mg in the soils could be due to low CEC values of soils resulting from low content of clay and organic carbon (Adamu *et al*., 2019).
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Table 1. Physical and chemical properties of soils of the study area.

Locations	Sand	Silt	Clay	Textural Class	pH (H_20)	Av.P mgkg-^{1}	N gkg^{-1}	O.C gkg^{-1}	Exchangeable bases (CEC) cmolkg^{-1}				CEC cmolkg^{-1}
									Ca	Mg	K	Na	
Banyagi F1	61	18.4	20.6	SCL	4.57	12.61	0.07	1.91	1.27	0.35	0.09	0.16	1.87
Banyagi F2	59.7	20.3	20	SCL	4.61	12.81	0.05	1.33	1.63	0.41	0.1	0.24	56.67
Nasarafu F1	57.3	22.3	20.4	SL	4.69	14.41	0.48	4.61	1.85	0.51	0.09	0.36	60.56
Nasarafu F2	58.5	21.2	20.3	SL	4.81	11.81	0.43	1.99	1.62	0.62	0.1	0.38	56.77
Bangaie F1	71.2	18.4	10.4	SL	5.31	8.83	0.39	1.18	1.61	1.01	0.04	0.11	57.51
Bangaie F2	69.9	19	11.1	SL	4.95	8.57	0.35	1.71	1.47	0.98	0.08	0.16	68.32
Daracita F1	60.7	29	10.6	SL	5.22	5.35	0.61	1.27	2.61	1.86	0.11	0.19	66.94
Daracita F2	61.4	28.3	10	SL	5.14	5.41	0.68	1.18	2.08	1.03	0.14	0.21	77.47
Film-Ta F1	53.1	30	16.9	SL	5.46	4.82	0.49	2.22	2.13	1.63	0.13	0.31	73.51
Film-Ta F2	52.8	31	16.2	SL	5.48	4.75	0.51	2.1	2.07	1.43	0.12	0.44	72.56
Min	52.8	18.4	10		4.57	4.75	0.05	1.18	1.27	0.35	0.04	0.11	73.38
Max	71.2	31	20.6		5.48	14.41	0.68	4.61	2.61	1.86	0.14	0.44	62.75
Mean	60.56	23.79	15.65	SL	5.08	6.2	0.4	3.18	1.83	0.66	0.1	0.26	64.69
SD	6.08	5.17	4.66		0.32	1.67	0.12	1.18	0.39	0.2	0.03	0.11	66.63
CV%	10.04	0.22	0.3		6.26	26.89	30.34	37.16	21.46	30.72	28.28	43.08	61.08

F1= farm one, F2= farm two, SL= sandy loam, SCL= sandy clay loam.

Generally the low CEC values of these soils of the study area could be as a result of the dominance of Kaolinite in the fine earth fraction (Ojanuga and Awujoola 1981). Exchangeable acidity and effective cation exchange capacity has a mean value of 1.53 $cmolkg^{-1}$ and 4.89$cmolkg^{-1}$ respectively. Percentage base saturation was medium with a mean value of 66.37%. This results corroborates with the finding of lawal *et al.*, (2012) were base saturation was average across study area in Katcha. The result implies that leaching was moderate and the dominance of basic cations in the exchange complex in the study location.

CONCLUSION AND RECOMMENDATION

From the results obtained in this study it can be concluded that the Fadama soils in the study area are dominantly sandy loams, low in pH, N, phosphorus, O.C, Ca, K and CEC, the values of Mg and Na are medium. Most soil chemical properties and the major fertility indices show low values which implies a deficiency in the nutrients. Liming may be necessary to reduce soil acidity, enhance P availability. Management practices such as application of organic manure, inorganic fertilizer and split dosing of N fertilizers would enable to improve the soil N status. Regular soil evaluation is necessary for sustainability and increase of crop production for economic development in the study area.

REFERENCES

Adamu, U. K., Amin M. A. Hussaini A. A. and Okolofo, C. E (2019). Physico-Chemical Properties of Soil as Influenced by Different Land Uses in Sumaila Local Government Area, Kano State. Dutse Journal of Agriculture and Food Security (DUJAFS) Vol. 6 No. 2, Dec. 2019 93-99.

Ahmed, K. (1995).Some constraints to Crop Production and Rehabilitation, north western Kana state. *Journal of Social and Management Studies* 1: 1-14.

Alarima, C. I., M. A. Busari, J. M. Awotunde, O. O. Olaniyi, T. Masunaga And T. Wakatsuki (2018). Physico-Chemical and Geochemical Properties Of Soils Under Sawah System of Inland Valleys In Nigeria. *Journal of Agricultural science and environment.*

Almu, H. Audu, M. D. (2001) Physico-Chemical properties of soils of A' Awa irrigation project areas, Kano State, in management of Wetland, Soil for Sustainable Agriculture and Environment. Proceedings of the 21st *Annual Conference of the Soil Science Society of Nigeria.* pp 135-138.

Bello, A. (2006). Keynote address by the minister of Agriculture and Rural Development. In: S. Idoga, S.A. Ayuba, A. Ali, O.O. Agbede and S.O. Ojeniyi (eds). Management of Fadama Soils for Environmental quality, Food Security and Poverty Alleviation in Nigeria. Proceedings of 30th Annual Conference of soil science science society of Nigeria. University of Agriculture Makurdi, Dec 5-9, 2005 pp. 6-8

Brady, N. C. and Weil, R. R. (2008). The nature and properties of soils, 14th ed. Pearson Prentice Hall. Upper Saddle River, New Jersey Columbus, Ohia, USA, 965 pp.

Esu, I. E. (1986). Morphology and classification of nupe sandstone formation in Niger state, Nigeria. Samaru journal of Agric. Rsh. 4:13-23

Farmer, G.W, and Wigley, T.M.L. (1985). Climatic trends for tropical Africa pp 1 -136 in A Research Report for the Overseas Development Administration. Farmer G.W (Ed).

Kparmwang,T. (1993). Characterization and classification of basaltic soils in the northern guinea savanna zone of Nigeria. Unpublished Ph.D Thesis. Dept. of Soil Sci.,Ahmadu Bello University, Zaria. pp.176.

Lawal, B. A., Adeboye, M. K. A. Oddofin, A. J. and M. I. S. Ezenwa. (2014). Assessment of properties and agricultural potentials of some Fadama soils in Katcha Local Government Area of Niger State, Nigeria. *Nigerian journal of technological research.* Vol. 9 no 2: 1-6.

Lawal, B. A., Odofin., A. J. Adeboye, M. K. A. and Ezenwa, M. I. S. (2012). Evaluation of selected fadama soils in Katcha Local Government Area of Niger State for arable cropping. *Nigerian Journal of Soil Science.* 22(2): 104-111.

Manu, A., Bationa, A. and Geiger, S. C. (1991).Fertility status of selected millet producing soils of West Africa with emphasis on phosphorus. Soil Science 152:315320.

Mohammed, T., Aduloju, M.O. and Lawal, B.A. (2021). Assessment and evaluation of soils supporting shea tree (*vitellaria paradoxa* c.f. gaertn) cultivation in bida, Niger state, NIGERIA. Nigerian Journal of Agriculture, Food and Environment. 17(1&2): 116-121.

Obalum S. E., J. C. Nwite, J. Oppong, C. A. Igwe and T. Wakatsuki. (2010). Comparative topsoil characterization of sawah rice fields in selected inland valleys around Bida, north-central Nigeria: textural, structural and hydrophysical properties. Paddy Water Environ (2011) 9:291–299 DOI 10.1007/s10333-010-0233-3.

Ojanuga, A. G. and Awujoola, A. I.(1981). Characteristics and Classifications of the Soils oft the Jos Plateau, Nigeria.l0:101-109.

Onyekwere I. N, and Ezenwa M. I. S. (2009). Characterization and classification of Barikin Sale, Nigerian Southern Guinea Savanna soils for sustainable rice production Nigerian Journal of soil science 19(2).

Onyekwere, I. N., Iwo, G.A. Eze, P.C. Okorieocha, D.S. and Nwokocha, C.C. (2013). Characteristics and management of fadama soils of Barikin sale Niger state, Nigeria. *Journal of Research in Agriculture and Forestry.* Volume 1, Issue 2, December 2014, PP 37-43

Pitty, A.F. (198). Geography and soil properties Methuen and Company Ltd, Oxford pp 261.

Raji, B. A, W. B. Malgwi, A. M. Falaki and T. Kparmwang, (2001). Characterization and classification of soils of the Jangargari alluvial complex in the semi-arid region of Nigeria. In: *Management of wetland soils for sustainable agriculture and environment.* Proceedings of the 25th annual conference of Soil Science Society of Nigeria. Pp 52 – 59.

Shefiu, M. (2007) Physico-chemical properties and fertility status of some Haplic plinthaqults in Bauchi Local Governmernt Area, Bauchi State, *Nigeria International Journal of soil Science* 2:314-319.

118 EFFECTS OF DIFFERENT NITROGEN SOURCES ON THE GROWTH OF MAIZE AND SOYBEAN IN AN INTERCROPPED SYSTEM

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Abstract

A pot experiment was conducted at the screen house of Federal University of Technology, Minna in the cropping season of 2019. The experimental soil was obtained from a location within Gidan Kwano campus with GPS coordinates of latitude 9º 31¹ N and longitude 6º 26¹ E. Maize variety Sammaz 27 and soybean variety TSB 4810 were intercropped per pot containing 14 kg of soil. A week after planting, they were thinned to one maize and one soybean seedling per pot, prior to the application of 4 nitrogen treatment sources. Treatments were then arranged in a Completely Randomized Design and replicated thrice. Basal applications of NPK and other micronutrients were supplied. Data collected were analyzed using ANOVA. Results showed that the different Nitrogen sources did not significantly affect the growth and leaf damage of maize. Excluding shoot biomass, nitrogen sources significantly affected all the growth parameters of soybean. Inoculated soybean nodulated significantly compared to soybeans treated with other nitrogen sources.

Key words: Growth, Intercrop, Maize, Nitrogen, Soybean.

INTRODUCTION

Maize is a cereal crop that is grown widely throughout the world in a range of agro-ecological habitat. More maize is produced annually than any other grain. The grains are rich in vitamin A, C and E, carbohydrates and essential minerals and contain 9% protein. They are also rich in dietary fiber and calories which are good source of energy (Shiferaw *et al., 2011*).

Maize is the most widely and popular cereal in Nigeria that is found in usage in almost every home either as food for humans or feed for animals and of utmost importance, it serves as raw materials for industries. 8% of the world's total 34.7million hectare of maize is produced by Africa. Nigeria which comes second after South Africa in Africa produced 8.7 million tonnes per hectare from 5.7 million tonnes per hectare which represents 1% of the world's total production in 2012. Nigeria's production is very low compared to the 273.8 million tonnes per hectare produced by USA in 2012. This study was conducted in the savanna zone of Nigeria which accounts for over 70% of maize production in Nigeria *(*Uyovbisere *et al., 2001*).

The explanation for this cannot be farfetched because the average yield per hectare in Nigeria is still very low to the tune of 1500kgha^{-1} in 2012 as stated by FAO. Low crop yield in sub Saharan

African countries have been attributed to challenges such as low soil fertility and change in climate (Ibeawuchi *et al., 2009*). Most maize production in Africa is rain fed. Anomalous rainfall can activate occasional drought which impacts yield negatively and in some cases total crop failure. On the other hand, a lack of nitrogen can reduce the production potential of maize (Chaudhary *et al., 2014*). As important as nitrogen is in plant life, it is low in soils of Nigerian Guinea Savanna, hence the need to supplement through mineral and biological sources. Abuse of the mineral source has dire environmental consequence. The most promising biological source with more economic returns is intercropping maize with soybean, such that the soybean can supply the needed amount of nitrogen for both plants. However, soybean unlike cowpea will need an initial supply of nitrogen within the range of 20-30 Kg N ha^{-1}. Thereafter, depending on the symbiotic effectiveness of the associating rhizobia, the soybeans can fix as much as 80 - 350 Kg N ha^{-1} (Mobasser et al., 2014). Intercropping is an age long practice that has so many advantages and few disadvantages if crops are incompatible. This intercrop system is nitrogen demanding hence the need to investigate the effect of different nitrogen sources on maize and soybean in an intercropped system at Gidan Kwano, Minna.

The objectives of the study are to:

1. Assess growth characteristics of intercropped soybean as affected by different nitrogen sources.
2. Estimate growth characteristics of intercropped maize as affected by different nitrogen sources

MATERIALS AND METHODS

Description of Study Area

The experiment was conducted at the screen house, School of Agriculture and Agricultural Technology, Federal University of Technology, Gidan Kwano, Minna which is within the Southern Guinea Savanna agro-ecological zone of Nigeria. The climate of Minna is sub-humid with a mean annual rainfall of 1248mm and distinct dry season from November to March . The mean maximum temperature remains high throughout, about 32^0C particularly in March and June *(Ojanuga, 2006)* .

Treatments and Experimental Design

The treatments consist of: Control (0 Kg N ha^{-1}), NPK 15:15:15 (20 Kg N ha^{-1}), Poultry Manure

(20 Kg N ha^{-1}) and USDA 110 as Rhizobium Inoculants at the rate of 2ml per plant. The treatments were arranged in a Completely Randomized Design (CRD) and replicated three times giving a total of twelve pots.

Soil Sampling amd Analysis

Soils were taken from the field at Gidan Kwano at a depth of 0-15cm with sterilized soil auger. A smaller portion of the soil sample collected (representative) was taken and sieved through a 2mm sieve in preparation for routine analysis of soil according to methods of International Soil Reference and Information Centre and Food and Agricultural organization (ISRIC/FAO, 2002). Thereafter, the poly pots were filled with 14 kg of soil and arranged as appropriate in the screen house.

Planting and Crop Management

Two seeds of each crop genotype were sown per poly pot containing 14 kg of soil. Thereafter, seeds were thinned to one plant per poly pot one week after planting (WAP). Fertilizer application was basal and as follows; 30 Kg P ha^{-1}, 60 Kg K ha^{-1}, 20 Kg N ha^{-1} and $ZnSO_4$ and MgSO4. Thereafter, the pots were weeded and watered till harvest at 6 WAP. Growth data were obtained at harvest and also Percentage Leaf Damage as $\frac{\text{number of damaged leaves}}{\text{total number of leaves}} \times 100$

$$\frac{\text{number of damaged leaves}}{\text{total number of leaves}} \times 100$$

Statistical Analysis

Data collected were subjected to Analysis of Variance (ANOVA) using SAS. Mean differences was separated using Duncan Multiple Range Test (DMRT) where the effects of treatments were significant

RESULTS

Table 1 shows the results obtained from the chemical properties of Gidan Kwano soil. Table 2 shows the growth parameter of intercrop maize and table 3 shows the growth parameter of intercrop soybean.

Table 1:Chemical properties of the soil of experimental location

Soil Parameters	Gidan Kwano
Sand (g Kg^{-1})	798
Silt (g Kg^{-1})	80
Clay (g Kg^{-1})	122
Textural class	Sandy Loam
pH in $CaCl_2$	4.45
Total Nitrogen (g Kg^{-1})	1.04
Organic Carbon (g Kg^{-1})	1.36
Available P (mg Kg^{-1})	13.87
Exchangeable bases (CmolKg-^{1})	
Mg^{2+}	0.45
Ca^{2+}	2.08
Na^{+}	0.27
K^{+}	0.09
Exchangeable Acidity (CmolKg-^{1})	
H^{+} and Al^{3+}	0.11

Table 2: Growth parameters of intercrop maize as affected by different Nitrogen sources

Nitrogen source	Plant height (cm)	Shoot biomass (gplant^{-1})	Root biomass (gplant^{-1})	Leaf Damage (%)
- N	64.9^{a}	7.2^{a}	2.5^{a}	0^{a}
+ Inorganic N	67.9^{a}	10^{a}	1.9^{a}	0^{a}
+ Organic N	71^{a}	8^{a}	2.3^{a}	0^{a}
+ USDA 110	66.1^{a}	10.6^{a}	2.4^{a}	0^{a}
$SE\pm$	2.1^{NS}	0.9^{NS}	0.3^{NS}	0^{NS}

Means with the same letter(s) indicated in the columns are not significantly different ($p \leq 0.05$).

NS = Not Significant ** = Highly Significant

* = Significant

Table 3: Growth, nodulation and percentage leaf damage parameters of intercrop soybean as

affected by different Nitrogen sources.

Nitrogen source	Plant height (cm)	Shoot biomass ($gplant^{-1}$)	Root biomass ($gplant^{-1}$)	Nodule number ($plant^{-1}$)	Nodule weight ($gplant^{-1}$)	Leaf Damage(%)
- N	35.4^{b}	0.8^{b}	0.6^{c}	1^{b}	0.04^{b}	45.6^{bc}
+ Inorganic N	38.9^{b}	1.4^{ab}	2.9^{a}	2.0^{b}	0.04^{b}	68.9^{a}
+ Organic N	41.9^{ab}	1.3^{ab}	0.6^{c}	2.0^{b}	0.02^{b}	59.8^{ab}
+USDA 110	48.9^{a}	1.5^{a}	1.5^{b}	10.0^{a}	0.2^{a}	37.2^{c}
$SE\pm$	1.9*	0.1^{NS}	0.3**	1.2**	0.02*	4.3**

Means with different letter(s) indicated in the columns are significantly different ($p \leq 0.05$).

NS = Not Significant ** = Highly Significant

* = Significant

Discussion

The result of chemical properties of Gidan Kwano soil (Table 1) shows that the soil had an extremely acidic reaction and low exchangeable acidity thus implying that the soil might have fertility problem (Adeboye *et al.,2009)*. The organic carbon content of the soil was very low which is typical of cultivated soils of the Nigerian savanna (Adeboye *et al.,2009*). The soil N was low and this may be attributed to low organic matter content which is the major reservoir of soil N. The low exchangeable bases may be due to very low clay and organic carbon content of the soils as suggested by Onyekwere and Ezenwa *(2009).*

The effects of Nitrogen sources on the growth and percentage leaf damage of intercrop maize (Sammaz 27) were not significant (Table 2) signifying that 20 Kg N ha^{-1} would not be enough for significant growth change because Maize as a cereal crop requires an appreciable amount of nitrogen (90 – 120 Kg N ha^{-1}) (Adesoji *et al*., *2015*). The application of 20 Kg N ha^{-1} of any form may just not be enough for maize alone, how much more the intercrop maize. The result of Table 2 shows that plant height and shoot biomass performance of maize plants were the poorest in control pots implying that nitrogen was low and poorly supplied to maize plants.

Root biomass of intercrop soybean (TSB 4810) was significantly affected by Nitrogen sources (Table 3) implying that nitrogen application, regardless of source can significantly affect root weight as far as the root aids uptake of nutrient and does not compete with the Leaf for carbohydrates.

Application of 20 Kg N ha^{-1} as inorganic fertilizer to intercrop soybean and its inoculation with USDA110 produced root biomass that was significantly superior to the root biomass of control plants (Table 3) reflecting the role nitrogen plays in the overall growth of the plant *(*Shiferaw *et al., 2011*). and also suggesting that biological nitrogen supply was significantly higher than nitrogen in the control pots. Conversely, application of organic nitrogen (20 Kg N ha^{-1}) produced root biomass that was the same and not statistically different from the root biomass of control plants implying that the organic N was probably not mineralized and available to the intercrops (Dobermann and Gassmann, *2004*). Nodule number and weight were significantly affected by Nitrogen sources (Table 3). Nodule number was significantly improved as a result of inoculation with USDA 110 compared to control and other Nitrogen sources implying that USDA 110 strain was quite infective compared to the exotic strains in control pot (Sanjay *et al., 2017*).

The reverse was the case under inoculated treatment.

Conclusion.

Although there was no significant evidence that showed that the intercrop maize benefited from the different Nitrogen sources applied, the study has however shown that the growth and nodulation characteristics of intercrop soybean was significantly affected by the supply of 20 Kg N ha^{-1} from different Nitrogen sources.

REFERENCES

Adeboye M.K.A., Osunde A.O., Ezenwa M.I.S., Odofin A.J and Bala A, (2009). Evaluuation of the fertility status and suitability of some soils of arable cropping in the southern guinea savanna of Nigeria. Nigerian journal of soil science. (19)2: 115 – 120

Adesoji, A.G., Abubakar.I.U and Labe D.A, (2015). Influence of incorporated legumes and nitrogen fertilization on maize (Zea mays L.) nutrient uptake in a semi-arid environment. IOSRJ Agric.Vet.Sci.,Vol. 8,(3verII), pp.01-08.

Chaudhary D.P., Sandeep K and Yadav O.P, (2014). Nutritive value of maize: Improvements, applications and constraints.

Dobermann A and Cassmann K.G, (2004). Environmental dimensions of fertilizer nitrogen: what can be done to increase nitrogen use efficiency and ensure global food security. In agriculture and the nitrogen cycle: assessing the impacts of fertilizer use on food production and the environment. Edited by Mosier. Island press, London, pp 260 - 278.

Ibeawuchi I.I, Obiefuna J.C., Ofor M.O., Ihem E.E., Nwosu F.O., Nkwocha V.I and Ezeibekwe I.O, (2009). Constraints of resource poor farmers and causes of low crop productivity in a changing environment. Researcher, 1: pp.48-53.

ISRIC/FAO, (2002). Procedures for Soil Analysis, sixth edition.Van Reeuwijk L.P (ed). International Soil Reference and Information Centre/Food and Agricultural Organisation, pp. 119.

Mobasser, H.R., Vazirimehr, M.R., and Rigi, K, (2014). Effect of intercropping on resources use, weed management and forage quality. International Journal of Plant, Animal and Environmental Sciences, 4, 706 - 713.

Ojanuga A.G, (2006). Agroecological zones of Nigeria manual. FAO/NSPFS, Federal Ministry of Agriculture and Rural Development, Abuja, Nigeria, pp.124.

Onyekwere I.N and Ezenwa M.I.S, (2009). Characterization and classification of Barkin Sale, Nigerian Southern Guinea Savanna Fadama soils for sustainable rice production. Nig. J. Soil. Sci.(19)2: 145 – 152.

Sanjay K.J., Msimibira L.A and Dakora F.D, (2017). Phylogenetically diverse group of bacterial symbionts isolated from root nodules of groundnut (*Arachis hypogea*) in South Africa. Syst. Appl. Microbiology. Vol 40, pp 215 – 226.

Shiferaw B., Prasanna B.M., Hellin J and Banzigar M, (2011). Feeding a hungry world; past success and future challenges to the role played by maize in global food security. 3, pp. 307 – 332.

Uyovbisere E.O., Elemo K.A and Tarfa B.D, (2001). Effect of Locust bean (*Parkia Biglobosa*) and neem (*Azadirachta Indica*) on soil fertility and productivity of early maize in savanna alfisol. Proceedings of the regional maize workshop, May 14 – 18, 2001, IITA-Cotonou, Republic of Benin, pp. 185 – 194.

119 EVALUATION OF IRRIGATION SUITABILITY FOR SURFACE IRRIGATION IN BAKAJEBA, NIGER STATE, NIGERIA

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Abstract

Irrigation is one of the most important inputs for an efficient and sustainable agricultural production. Many farmers are out of jobs during the dry season and prices of locally produced food are high as a result of food scarcity during this period. The objective of this study is to map potential irrigable areas based on soil physical properties and slope of the study area. To evaluate the land suitability for irrigation, parametric evaluation system was applied, using soil and land characteristics. Suitability classes were defined considering the value of suitability index. They were rated and used to calculate the overall suitability index. The overall soil suitability was estimated using the weightage of each factor to obtain potential irrigable sites. The data were combined using a multi-criteria decision approach to select suitable sites for irrigation. Landsat imagery with 30m resolution was used for the overall land suitability classification. The overall suitability shows that 59.0 % of the area have been classified highly suitable (S1) for irrigation and 32.0 % are moderately suitable (S2) for irrigation while 9.0 % has been classified as marginally suitable (S3). The study shows that GIS based suitability evaluation could ease the identification and mapping of suitable land for irrigation purpose. Important management information for the study area can be easily deduced from the land suitability maps for enhancing sustainable development of agriculture in the country. It is hoped that the information generated from this study will equip potential users with information that is essential for the sustainable management of the soil of the study area for sustainable agriculture and serve as a means of readily identifying opportunities for farmers and investors to access and put the land into suitable use.

Keywords: Bakajeba; GIS; irrigation; land suitability and land evaluation.

INTRODUCTION

Irrigation is one of the most important inputs for an efficient and sustainable agricultural production (Gundogdu *et al.*, 2002). Many irrigation projects, especially in the developing tropical regions, are embarked upon without any land capability assessment, resulting in avoidable and undesirable ecological consequences (Umweni and Ogunkunle, 2014). In Nigeria, as in many developing countries, land use practices are not based on suitability analysis. Increased pressure on the available land resources may result in land degradation. Reliable and accurate land evaluation is therefore indispensable to the decision-making processes that will support sustainable rural development. If self-sufficiency in agricultural production is to be achieved, land evaluation technique will be required to develop models for predicting land suitability for irrigated agricultural crops (Guo and He, 1998). There are small-scale irrigation activities taking place in Niger state throughout the year, but there is no study available which analyses the land suitability for irrigated agriculture in Lapai-Agaie irrigation scheme of Bakajeba village. Also, the extent and geographical locations of potentially irrigable lands using surface irrigation methods have not been identified.

MATERIALS AND METHODS

The study was conducted at Lapai-Agaie Irrigation scheme which lies on latitude 09^{o} 13' 09.83 " N and longitude 06^{o} 35'87.9 " E near Bakajeba village along Paiko-Lapai road in Niger State.

Soil Identification and Mapping: this was done using by rigid grid method of soil survey with the aid of soil auger. Traverses were cut at 100m apart along a baseline and observation points were at 100m apart along each traverse. Auger holes were made at each point down to a depth of 100cm and soil was examined at each 20cm incremental depth interval for the 100m depth. Morphological properties were recorded at each point including soil texture, colour, consistence, vegetation, evidence of rock outcrop and so on. The points were further grouped on the basis of the recorded morphological features. The area was delineated into 3 mapping units and two profile pits were dug in each mapping unit. A total of six (6) profile pits were dug at points typical to each mapping unit. Each of the profile pits was demarcated into different horizon and soil description was done. Soil samples were collected at each horizon in the profile pits for laboratory analysis.

Physical Analysis: The basic infiltration rate was determined on the field using a double ring infiltrometer method. Effective soil depth was determined by using measuring tape to measure from the soil surface to the upper boundary of the limiting horizon. Drainage characteristics was determined by using Munsell Colour Charts. Water retained at field capacity (FC) and permanent wilting point (PWP) was determined using the saturation water percentage-based estimation models of Mbagwu and Mbah (1998).

$$F.C = 0.79\ (SP) - 6.22\ (r = 0.972)$$

$$P.W.P = 0.51\ (SP) - 8.65\ (r = 0.949)$$

Chemical Analysis: Soil texture was determined using Bouyoucous hydrometer method with sodium hexametaphosphate as dispersing agent. The textural classes of the soils were further determined using IUSS soil Textural Triangle. Soil pH was determined using a glass electrode pH meter in soil water and soil $CaCl_2$ ratio of 1:2.5. The extract used for determination of the soil pH in water was used to determine the electrical conductivity of the soil. Organic carbon was determined using Walkley-Black wet oxidation method. Available phosphorus was extracted with the Bray P 1 method and P in extract was determined using spectrophotometer. Soil sample for exchangeable bases ($Ca2^+$, $Mg2^+$, K^+ and Na^+) was extracted with 1N neutral ammonium acetate (NH4OAc) solution and amounts of K^+ and Na+ in solution was measured using a flame photometer while $Ca2^+$ and $Mg2^+$ was measured using Atomic Absorption Spectrophotometer (AAS). Exchangeable acidity (H^+ and $Al3^+$) was determined by titrimetric method. Effective Cation Exchange Capacity (ECEC) was determined by using flame photometer. Sodium Adsorption Ratio was by calculation using this formula; SAR= $Na^+ / \sqrt{(Ca + Mg)}^{++} / 2$

Exchangeable Sodium percentage was calculated using the formula below

$$ESP = \frac{\text{Exchangeable } Na^+ \text{ (cmol/kg)}}{\text{Cation Exchange Capacity (cmol/kg)}} \times 100$$

To evaluate the land suitability for irrigation, parametric evaluation system of sys (1985) was applied, using soil and land characteristics. The data generated from the field for each pedon was used to calculate the suitability index for irrigation. The data were combined using a multi-criteria decision approach to select suitable sites for irrigation. Landsat imagery with 30m resolution was used. The imagery was subjected to digital image processing. The overall soil suitability was estimated using the weightage of each factor (slope, soil texture, Infiltration rate, Effective soil depth Available water capacity and drainage) to obtain potential irrigable sites.

Table 1: Land characteristics rating and suitability index for irrigation of the pedons

Land quality	MP1	MP2	MP3
Texture	85(S1)	95(S1)	90(S1)
pH	100(S1)	100(S1)	100(S1)
Infiltration rate	85(S1)	100(S1)	100(S1)
Available Water Capacity	75(S2)	80(S1)	85(S1)
Organic Carbon	65(S2)	85(S1)	75(S2)
Effective Soil Depth	85(S1)	100(S1)	100(S1)
Slope	95(S1)	85(S1)	65(S2)
Drainage	100(S1)	90(S1)	100(S1)
CEC	100(S1)	90(S1)	100(S1)
SAR	85(S1)	90(S1)	90(S1)
ESP	90(S1)	90(S1)	85(S1)

Table 2: Land characteristics rating and suitability index for irrigation of the study area

Soil quality	Suitability index	Suitability class
Texture	81	S2
pH	100	S1
Infiltration rate	92	S1
Available Water Capacity	61	S2
Organic Carbon	54	S3
Effective Soil Depth	92	S1
Slope	69	S2
Drainage	95	S1
CEC	87	S1
SAR	75	S2
ESP	75	S2

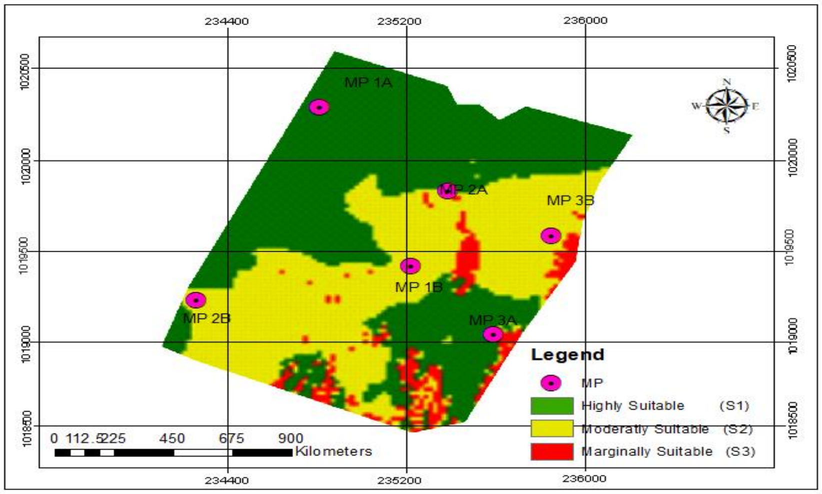

Fig. 1: Irrigation Suitability Map of the Study Area

DISCUSSION

All mapping units had sandy-loam soil texture. This could be attributed to similar parent materials and environment in which the soils were developed (Robert *et al.*, 2019). The suitability index was rated 85%, 95% and 90% at MP1, MP2 and MP3 respectively and are all classified as highly suitable (S1) for surface irrigation. All soils were rated highly suitable (S1) for pH with suitability index of 100%. pH is an important soil property that determine solubility and reaction of soil elements such as Al and Mn (John *et al.*, 2018). Soil pH range of 5.5 to 7.0 have been established as favourable for release of most crop/plant nutrients (Brady and Weil, 2002). Infiltration rate was highly suitable in all mapping units with index rate of 85% at MP1 and 100% MP2 and MP3 respectively. Organic carbon was rated moderately suitable (S2) at MP1 and highly suitable (S1) at MP2 and MP3. The soil organic carbon ranged from 2.14 to 8.57g kg-1 and was low according to Esu (1991) fertility classification. Organic matter play important role in soil by binding soil mineral particles and provide exchange sites for nutrients (Robert *et al.*, 2019). Available water capacity was moderately suitable (S2) at MP1 and MP2 while MP3 was rated highly suitable (S1) with index value 85%. CEC was rated highly suitable (S1) at MP1 and MP3 while MP2 was moderately suitable (S2) with index of 75%. Sodium Absorption Ratio (SAR) was rated as highly suitable in all soils of the mapping units. Exchangeable Sodium Percentage (ESP) was highly suitable in all soils of the mapping units.

A large proportion of the soil were imperfectly drained and rated 90% in MP2 while MP1 and MP3 were rated 100% for irrigation suitability. This is considered to be suitable for irrigation agriculture. With reference to slope, the soils were rated highly suitable at MP1 and MP2 with suitability index of 95 and 85 respectively while MP3 was rated Moderately suitable with a suitability index value of 65% for surface irrigation.

The overall land suitability (fig.1) shows that 59.0 % of the area have been classified highly suitable (S1) for irrigation and 32.0 % are moderately suitable (S2) for irrigation while 9.0 % has been classified as marginally suitable (S3). The limiting factor that lowered the soil to S3 is mainly the soil organic carbon of the soil. Special management of these areas through increased fertilizer and organic matter application may be required for accelerated recovery.

CONCLUSION

In conclusion, the study shows that GIS based suitability evaluation could ease the identification and mapping of suitable land for irrigation purpose. Important management information for the study area can be easily deduced from the land suitability maps for enhancing development of agriculture in the country. Concerned investors should incorporate GIS-based multi-criteria decision-making analysis in selecting sites for irrigation, this will help to generate maximum returns from agricultural land and sustainable production.

REFERENCES

Brady, N.C. and Weil, R.R. 2002. The nature and properties of soils. Pearson Publication, 12th Edition pg, 517- 528.

Esu, I.E., 1991. Detailed soil survey of NIHORT Farm at Bunkure Kano State, Nigeria. Institute for Agricultural Research, Ahmadu Bello University, Zaria, Nigeria. 72pp.

Gundogdu, K.S., Degirmenci, H. and Demirtas, C. 2002. Creation of GIS supported database in irrigation project management. AGROENVIRON, 26-29 October 2002.

Guo, L.S., and He Y.S. (1998). Integrated multi-criteria decision model: A case study for the allocation of facilities in Chinese Agriculture: J. Agric. Engng Res. 1999, Silsoe Research Institute (Article No. jaer.1998.0393. http://www.idealibrary.com), Vol. 73: 87-94.

John, J.T., Balthazar M.M., Johnson M.S., Ernest S. and Sibaway B.M., 2018. Pedological Characterization and Classification of Some Typical soils in Three Agro-Ecological settings of South-Eastern Tanzania. *International Journal of Scientific and Engineering Research,* Volume 9. ISSN 2229-5918.

Mbagwu, J.S. & Mbah, C.N. 1998. Estimating water retention and availability of soils from their saturation percentage. Comm. *Soil Science Plant Analysis*, 29, 913-922.

Robert, E.O., Lawal, B.A. and Odofin A.J. 2019. Geographic Information System (GIS)-Based Digital Mapping of Soil Properties for Arable Agriculture in Ike-Bunu, Kogi State. *Agricultural Society of Nigeria, Annual conference proceedings*. Pp 62 – 65.

Sys, C., 1985. Land Evaluation. International Training Centre for Postgraduate Soil Scientist, Vol. 1, 2 and 3, State University Ghent.

Umweni, A.S., and Ogunkunle, A.O. 2014. Irrigation capability evaluation of Illushi floodplain, Edo State, Nigeria. International Soil and Water Conservation Research, 43(2):79-87.

120 EFFECTS OF BIOCHAR AND NITROGEN FERTILIZER ON SOIL ORGANIC CARBON, NUTRIENT RETENTION AND MAIZE PERFORMANCE

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Abstract

Biochar, a rich carbon source has a significant effect in increasing soil fertility and physico – chemical properties. The experiment was aimed at studying the effects of biochar and nitrogen fertilizer on soil organic carbon, nutrient retention, and maize performance The trial was a 3 x 4 factorial experiment arranged in a Randomized Complete Block Design (RCBD) with three levels of biochar (0, 2.5 and 5 t/ha) and four levels of urea fertilizer (0, 40, 80, 120 kg N / ha) replicated three times. Data collected were analyzed using general linear model SAS software at 5 % level of significance while differences between treatment means were separated using Duncan Multiple Range Test (DMRT). The result showed that application of biochar produced from Piliostigma reticulatum and Nauclea spp (common shrubs found on fallow lands in Minna) significantly increased ECEC but did not alter organic carbon significantly. Biochar application had no effect on seedling emergence, plant height, stover and grain yield of maize. Nitrogen fertilizer application however had significant effect on plant height, stover and grain yield of maize but had no significant effect on the seedling emergence. Higher rates of biochar application and more long-term researches on biochar are needed to facilitate the understanding of its effects on soil properties as it is envisaged that such research will indicate more significant effects of biochar on soil properties.

KEYWORDS: Biochar; Nitrogen fertilizer; Physico – chemical properties; organic carbon; maize.

INTRODUCTION

In sub-Saharan Africa, decline in food production has become a major challenge as a result of increasing human population and poor fertility of available land for agricultural production among other socio-economic and political factors (Partey et al., 2013). Increased soil acidity and cost of fertilizer, soil fertility depletion, yield reduction, and threat to human health amongst other factors are some of the resultant effects of nutrient leaching (Özacar, 2003; Laird et al., 2010). Developing effective ways of retaining soil nutrients is therefore a necessity for successful agriculture to be ensured. One of the relevant crops in Nigeria is the maize crop (*Zea mays*) which ranked third in terms of importance among the cereal crops where sorghum ranked first and millet second (FAO, 1997). The ploughed horizon is dominated by coarse textured soils with low cation exchange capacity, organic carbon, total nitrogen, low to medium available phosphorus (Lawal et al., 2013; Afolabi et al., 2014). This implies that these soils have low clay content in addition to their low organic matter.

These two components are however, necessary for efficient retention of nutrients in soils. In addition to the clay content being low, the dominant clay type in these soils are the kaolinites which are known for their low activity. In these soils, the organic matter is mostly lost through rapid mineralization, this makes their effect to be short-lived even with the addition of manure (in addition to inorganic fertilizers). Application of biochar is now considered as a potential valuable input and remedy to restore soil fertility (Wardle et al., 2008). As a form of organic matter, it is stable in soil and therefore compensates for the limitations associated with clay and organic matter in tropical soils. The research was carried out to assess the effects of biochar and nitrogen fertilizer on soil organic carbon (OC), effective cation exchange capacity (ECEC) and maize performance in Minna, Niger state.

MATERIALS AND METHODS

The Teaching and Research Farm of School of Agriculture and Agricultural Technology, Federal University of Technology, Minna was the experimental site. It is found between latitudes 9^0 30′ 30.10″ and 9^0 31′ 2.92″ and longitudes 6^0 25′ 57.61″ of the equator with an elevation of 190 – 216 m above sea level and characterized by a sub-humid tropical climate, a temperature up to 33^{o}C and an average annual rainfall of 1284 mm (Ojanuga, 2006). The biochar used in this study was produced in March 2016 (during the dry season) using shrubs (*Piliostigma reticulatum* and *Nauclea* spp) from adjoining fallow lands. The trial was a 3 x 4 factorial experiment arranged in a Randomized Complete Block Design (RCBD) with three levels of biochar (0, 2.5 and 5 t/ha) and four levels of urea fertilizer (0, 40, 80, 120 kg N/ha) replicated three times. The maize planted is of Oba super II variety. Two seeds per hole were seeded at a 3 cm depth at a spacing of 75 x 25 cm (intra- and inter-row) on ridges. After 2 weeks, thinning was done, leaving one plant per stand. Manual weeding done at 2 and 6 weeks after planting. Also, the experiment was done in the open field and the crop could dry before harvesting. A total of thirty-six plots, each measuring 4 x 4 m were used for the experiment.

Initial soil characteristics was determined by randomly collecting samples from five points on the experimental site at a depth of 0 – 15 cm. These samples were mixed to get a representative sample from which a sub – sample was extracted, air-dried, crushed gently using a porcelain mortar and pestle, and passed through 2 mm sieve and 0.5 mm sieve (for organic carbon determination). Soil parameters measured included particle size distribution (hydrometer method), pH (soil-water ratio of 1:2), total nitrogen (micro-Kjeldahl process), available phosphorus (Bray P-1 method), exchangeable bases (Ca^{2+}, $Mg^{2+,}$ K^{+} and Na^{+}), Organic Carbon (Walkley-Black wet oxidation method), Exchangeable acidity (Al^{3+} and H^{+}) and Effective Cation Exchange Capacity (determined by summation method which entails the addition of the exchangeable bases with the exchangeable acidity). Same procedure was repeated after harvesting for determination of organic carbon and effective cation exchange capacity.

Crop parameters measured were Seedling Emergence, Plant Height, Grain Yield and Stover Yield. Statistical analysis of the data was carried out using the General Linear ModelSAS software at 5% level of significance while differences between treatments means was separated using Duncan Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Initial Soil Characteristics (as at 2016)

The initial soil characteristics of the experimental site are as presented in Table 1. The textural class is sandy loam. The pH (in water) was strongly acidic (5.4). Organic carbon and total nitrogen (3.80 and 0.11 g/kg respectively) were very low. ECEC (10.09 cmol/kg) and available phosphorus (6.89 mg/kg) were low. Sodium, potassium and magnesium and calcium (ranging from 0.26 – 6.00 cmol/kg) were low to high. These properties are not unexpected of a savanna soil as they conform to findings of other authors (Afolabi et al., 2014 & Lawal et al., 2013).

Table 1: Initial Soil Characteristics (as at 2016)

Soil Properties	Values
Particle Size Distribution (g/kg)	
Sand	792
Silt	33
Clay	175
Texture	Sandy Loam
pH (H_2O)	5.40
OC (g/kg)	3.80
N (g/kg)	0.11
Available P (mg/kg)	6.89
Exchange Bases (cmol/kg)	
Ca	6.00
Mg	2.53
K	0.35
Na	0.26
Exchangeable Acidity (H and Al) (cmol/kg)	1.02
ECEC (cmol/kg)	10.16

Table 2: Chemical Properties of Biochar Used

Properties	Values
pH (H_2O)	8.30
OC (%)	63.5
N (%)	0.90
P (%)	1.70
Ca	3.54
Mg	3.08
K	2.74
CEC (cmol/kg)	96.09

Chemical properties of biochar used in the study
These properties are in line with the results of biochar produced by other authors (Fagbenro et al., 2013; Jindo et al., 2014). From their reports, biochar is alkaline, contains high contents of carbon and low nitrogen.
It is also characterized by a high C: N ratio. Fagbenro et al. (2013) produced biochar from saw dust with C: N of 80.4 which is similar to that of 70.5 used in this study.

Effects of Biochar and Nitrogen Fertilizer on OC, ECEC, Growth and Yield of Maize
The main effects of biochar on OC and ECEC of soil, seedling emergence, plant height, stover and grain yields of maize are presented in Table 3. Application of biochar significantly ($p \leq 0.05$) increased the ECEC but had no significant effect on the OC. When 2.5 and 5t/ha of biochar were applied, there was significant increase in ECEC. This is in line with the findings of other authors (Yamato et al., 2006; Zheng, 2010). Biochar application had no significant effect on any of the growth and yield parameters. Fertilizer application had no significant effect on seedling emergence even though it had significant ($p \leq 0.05$) effect on plant height, stover and grain yields of maize. Biochar had no significant effect on seedling emergence, plant height, stover and grain yield of maize. This might be due to crop response to biochar amendment, which depends on the rate of application (Ogunyemi et al., 2018; Zhang et al., 2012).

CONCLUSION AND RECOMMENDATION
Application of biochar produced from *Piliostigma reticulatum* and *Nauclea* spp (common shrubs found on fallow lands in Minna) significantly increased ECEC but did not alter organic carbon significantly. Furthermore, biochar application had no effect on seedling emergence, plant height, stover and grain yield of maize. Nitrogen fertilizer application however had significant effect on plant height, stover and grain yield of maize but had no significant effect on the seedling emergence. Higher rates of biochar application and more long-term researches on biochar are needed to facilitate the understanding of its effects on soil properties as it is envisaged that such research will indicate more significant effects of biochar on soil properties.

Table 3: Effects of Biochar and Nitrogen Fertilizer on Organic Carbon (OC), Effective Cation Exchange Capacity (ECEC), Seedling Emergence, Plant Height, Stover Yield and Grain Yield of Maize

	OC (g/kg)	ECEC (cmol/kg)	Seedling emergence (%)	Plant height (cm)	Stover yield (t/ha)	Grain yield (t/ha)
Biochar (B) (t/ha)						
0	9.05[a]	12.24[c]	81.00[a]	184.03[a]	3.75[a]	1.28[a]
2.5	9.49[a]	17.15[b]	81.00[a]	173.79[a]	4.10[a]	1.27[a]
5	9.59[a]	19.54[a]	80.00[a]	177.22[a]	4.31[a]	1.36[a]
SE ±	0.05	0.01	1.58	4.46	0.32	0.12
Fertilizer (F) (kg N/ha)						
0	9.36[a]	16.48[a]		134.09[c]	2.08[c]	0.12[d]
40	9.16[a]	15.48[a]	-	178.82[b]	3.95[b]	1.13[c]
80	9.34[a]	16.59[a]	-	198.98[a]	4.90[ab]	1.70[b]
120	0.06	0.01	-	201.45[a]	5.28[a]	2.26[a]
SE ±			-	5.15	0.37	0.14
Interaction						
B × F	NS	NS	NS	NS	NS	NS

Means within a factor and followed by different letters are significantly different at $p \leq 0.05$. SE ± = standard error, NS = not significant.

References

Afolabi, S. G., Adeboye, M. K. A., Lawal, B. A., Adekanmbi, A. A., Yusuf, A. A. and Tsado, P. A. (2014). Evaluation of some soils of minna southern guinea savanna of Nigeria for arable crop production. Nigerian Journal of Agriculture, Food and Environment. 10(4):6-9, 10(4), 6–9.

Fagbenro, J., Oshunsanya, S., & Onawumi, O. (2013). Effect of saw dust biochar and npk 15:15:15 inorganic fertilizer on Moringa oleifera seedlings grown in an oxisol. Agrosearch, 13(1), 57. https://doi.org/10.4314/agrosh.v13i1.6

Jindo, K., Mizumoto, H., Sawada, Y., Sanchez-Monedero, M. A., & Sonoki, T. (2014). Physical and chemical characterization of biochars derived from different agricultural residues. Biogeosciences, 11(23), 6613–6621. https://doi.org/10.5194/bg-11-6613-2014

Laird, D., Fleming, P., Wang, B., Horton, R., & Karlen, D. (2010). Biochar impact on nutrient leaching from a Midwestern agricultural soil. Geoderma, 158(3–4), 436–442. https://doi.org/10.1016/j.geoderma.2010.05.012

Lawal, B. A., Ojanuga, A. G., Tsado, P. A., & Mohammed, A. (2013). Characterization, classification and agricultural potentials of soils on a toposequence in southern guinea savanna of Nigeria. International Journal of Agricultural and Biosystems Engineering, 7(5), 330–334.

Ogunyemi, A. M., Otegbayo, B. O., & Fagbenro, J. A. (2018). Effects of NPK and biochar fertilized soil on the proximate composition and mineral evaluation of maize flour. Food Science & Nutrition, 6(8), 2308–2313.

Özacar, M. (2003). Adsorption of phosphate from aqueous solution onto alunite. Chemosphere, 51(4), 321–327. https://doi.org/10.1016/S0045-6535(02)00847-0

Partey, S. T., Preziosi, R. F., & Robson, G. D. (2013). Maize residue interaction with high quality organic materials: Effects on decomposition and nutrient release dynamics. Agricultural Research, 2(1), 58–67. https://doi.org/10.1007/s40003-013-0051-0

Wardle, David A, Nilsson, M.-C., & Zackrisson, O. (2008). Fire-derived charcoal causes loss of forest humus. Science, 320(5876), 629.

Yamato, M., Okimori, Y., Wibowo, I. F., Anshori, S., & Ogawa, M. (2006). Effects of the application of charred bark of Acacia mangium on the yield of maize, cowpea and peanut, and soil chemical properties in South Sumatra, Indonesia. Soil Science and Plant Nutrition, 52(4), 489–495. https://doi.org/10.1111/j.1747-0765.2006.00065.x

Zhang, A., Liu, Y., Pan, G., Hussain, Q., Li, L., Zheng, J., & Zhang, X. (2012). Effect of biochar amendment on maize yield and greenhouse gas emissions from a soil organic carbon poor calcareous loamy soil from Central China Plain. Plant and Soil, 351(1), 263–275.

Zheng, W., Sharma, B. K., & Rajagopalan, N. (2010). Using biochar as a soil amendment for sustainable agriculture. Waste utilization--Biochar.

121 IMPLICATION OF LAND SURFACE TEMPERATURE AS A DRIVER OF LAND COVER CHANGES ON THE URBAN DYNAMICS OF ABUJA NIGERIA

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Abstract

The influence of climatic change and global warming are greatly telling on every urban environment and Abuja is not exempted. This is evident in the level of different land cover transitions which have resulted to significant changes to environmental parameters like Land Surface Temperature (LST), Enhanced Vegetation Index (EVI), and Normalized Difference Vegetation Index (NDVI). Hence, it has become necessary for the understanding of the Implication of land cover changes to land surface temperature rise in Abuja. Adopting Remote Sensing technique, imageries of Landsat 7 (ETM +) and Landsat 8 (OLI) of Abuja for four epochs 1990, 2001, 2012, and 2021 were used. The Maximum Likelihood supervised classification method was employed to extract land use land cover classes of Abuja with various accuracy metrics to ascertain the classification accuracy. LST of Abuja was derived using band 6 for Landsat 7 and band 10 for Landsat while bands 1-6 was used to estimate NDVI, EVI and NDBI. Statistically the land cover transitions of the study area were computed. In the last 31 years, it was observed that Water Body and Vegetation had reduced, Vegetation declined from 34.321% to 30.416%. Bare-Land drastically reduced from 54.628 % to 49.442%. Built-Up had increased from 5.424% to 16.982%. Finally, Pearson's correlation (R) between the LST with EVI and NDVI falls between 0.77 to 0.96 and the Regression value (R^2) between 0.61 to 0.87, which shows that, Built-Up had affected LST in the last 31years of the study. It is recommended that Federal Capital Development Authority (FCDA), and other relevant agencies in charge of Abuja master plan implementation, should ensure full enforcement of Abuja Master plan, in order to strike a balance between a beautiful city and natural environment.

Keywords: Land Surface Temperature, Enhanced Vegetation Index, Normalized Difference Built-up Index, Land use/Land cover, Normalized Difference Vegetation Index.

Introduction

In search of a befitting new Capital City for Nigeria, after Lagos lost some of the criteria of a Capital City 1976, Abuja was selected with full government operation commencing in 1991. Thirty-one years down the line some of the reasons for relocating the capital to Abuja are being experienced with a lot of misuse and illegal use of land occurring in Abuja. Several urban development control strategies by relevant authorities have been formulated, yet people are not responding, leading to an increase in built-up areas yearly. The influence of climate change and global warming is greatly telling on every urban environment and Abuja is not exempted. This is evidence in the level of different land cover transitions which have resulted to significant changes to environmental parameters like Land Surface Temperature (LST), Enhanced Vegetation Index (EVI), and Normalized difference Vegetation Index (NDVI). Hence, it has become necessary for the understanding of the implication of land surface temperature as a driver of land cover changes on the urban dynamics of Abuja.

The LST is a tool for acquiring the temperature condition of a geographical location on the earth. According to Dash *et al*. (2002). LST is an important variable required for various applications such as Climatological, Hydrological, Agricultural, and other related studies. The Normalized Difference Vegetation Index (NDVI) is another index that predicts the vegetation health condition of any geographical location with the use of Remote Sensing and GIS tools. According to Jiang *et al* (2006), the normalized difference vegetation index (NDVI) is used to retrieve vegetation canopy for biophysical properties. Similarly, the Normalized Difference Built-up index (NDBI) is used in mapping out built-up areas. According to Macarof and Statescu (2017), NDBI is an indicator of development intensity and an indicator of urban impervious surface. The Enhanced Vegetation Index (EVI) is used for crop monitoring and is widely used and recommended to detect Spatio-temporal vegetation patterns like land management, crop rotations, or land use change (Kibret *et al.*, 2021)

Study Area

The study area (Abuja) falls in North Central Zone of Nigeria. It is the capital and among the ten most populous city of Nigeria which was built in the 1980s. As shown in figure 1. Abuja is in the guinea savannah of the middle belt between latitude 8° 25″ and 9° 25″ North of the Equator and longitude 6° 45″ and 7° 45″ East of the Greenwich, occupying an area of about 8,000 square kilometres sharing boundaries with Niger state at the west and northwest, Kaduna state to the northeast, Nasarawa State to the east and south, and Kogi State to the southwest. The annual rainfall is about 1,631.7 mm. The annual mean temperature ranges between 25.8°C and 30.2°C Adeyeri et al., (2015).

According to the 2006 census by National Population Commission (NPC) Nigeria, the city of Abuja had a population of 1,430,000. The indigenous inhabitants of Abuja are the Gbagyi, other groups in the area include the Bassa, Gwandara, Gade, Dibo, Nupe and Koro. Finally, Abuja, the Federal Capital, and a planned modern city, is located near the centre of Nigeria's territory.

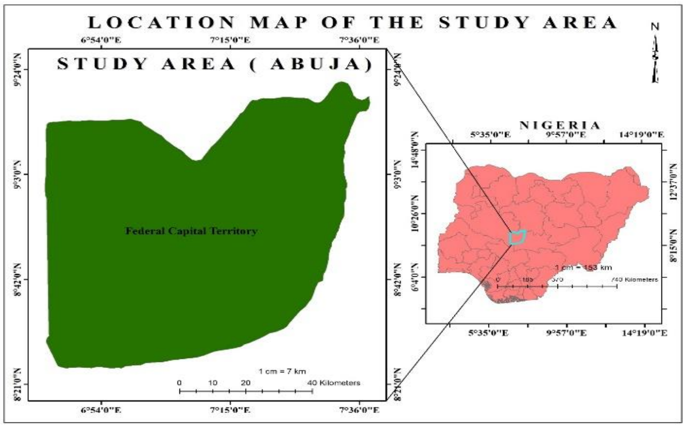


Figure 1: Study Area

METERIALS AND METHOD

Materials: The table 1.0 below shows the data acquired for this research work.

S/N	Dataset	Scale/ Resolution	Source	Coordinate System	Acquisition Date
1	Nigeria Shapefile		Diva-GIS (https://www.diva-gis.org/gdata.)	GCS_WGS1984 UTM Zone 31N	15th Of August 2021.
2	Landsat 7(ETM+) & 8 (OLI) Imagery Path/Row: 189 - 54	30m x 30m	NASA/USGS https://earthexplorer.usgs.gov/	GCS_WGS1984 UTM Zone 31N	16th of August 2021.

Method

Land use cover: The land use cover map was produced to observe the effect of the specified parameters on each sector within the study area. Landsat 7 (ETM+) and Landsat 8 (OLI) imageries were acquired for the study, band composites were formed from the imageries with bands 6, 5, 4 combinations for Landsat 8 and 5, 4, 3 for Landsat 7. Maximum likelihood supervised classification was then applied to the clipped imagery in the ArcMap environment, mapping four major classes such as Built-up, Bare land, Vegetation, and Water body, using the Classification Scheme deduced by Anderson (1971).

Specified Parameters

The following Parameters were assessed for the execution of this Research.

The NDVI for the years 1990, 2001, 2012 and 2021 was calculated using the equation (1) reported by Jiang, *et al*. (2006), the band 4(RED) & 5(NIR) of Landsat 8 and band 3(RED) & 4(NIR) of Landsat 7 was used to carry out the NDVI.

$$NDVI=\frac{NIR-RED}{NIR+RED} \qquad (1)$$

The NDBI of the specified years were estimated using the equation (2) by Jiang, *et al*. (2007), the band 6(MIR) & 5(NIR) of Landsat 8 and band 5(MIR) & 4(NIR) of Landsat 7 was used to carry out the NDBI in the ArcMap Environment. NDBI = MIR – NIR / MIR + NIR ………………………. (2)

Similarly, the specified years were also the epoch used in the assessment of LST using the equation (3) by Ikechukwu, *et al*. (2016), the band 10 of Landsat 8 and band 6 of Landsat 7 was used to carry out the LST. LST= [BT/ (1+0.0015 X BT/1.4388) X Ln(Ɛ)] ……. (3)

The EVI for the year 1990, 2001, 2012 and 2021 was calculated using the equation (4) by Matsushita et al. (2007), band 2, 4 & 5 of Landsat 8 and band 1, 3 & 4 of Landsat 7 was used to carry out the EVI. Finally, the Relationship between LULC and specified parameters were estimated per statistical influence.

$$EVI = G \times \frac{\rho_{nir} - \rho_{red}}{\rho_{nir} + (C_1 \times \rho_{red} - C_2 \times \rho_{blue}) + L}$$

………………………………………. (4)

RESULT AND DISCUSSION

Land use cover: Table 2.0 below shows the land cover change of the study area within an epoch of thirty-one years. Results showed that Bare land had reduced drastically within the period, likewise Vegetation whereas; Built-Up had increased over the epochs in the study area. It also showed that Water Body was stable between 1990 to 2001 epoch but decreased between 2012 to 2021 epoch. Figure 2 shows the study area's land use/land cover map for a span of 31 years.

Table 1.0: Showing the LULC coverage for the last 31 Years in Abuja

Years	LULC	(KM^2)	%	Years	LULC	(KM^2)	%
1990	Bare land	4017.59058	54.628	2012	Bare land	3889.69664	52.889
	Vegetation	2524.12181	34.321		Vegetation	2290.61793	31.146
	Water Body	413.835070	5.627		Water Body	335.363056	4.560
	Built-Up	398.905531	5.424		Built-Up	838.848908	11.405
Years	LULC	(KM^2)	%	Years	LULC	(KM^2)	%
2001	Bare land	3951.40050	53.728	2021	Bare land	3636.18865	49.442
	Vegetation	2419.98276	32.905		Vegetation	2236.93042	30.416
	Water Body	403.171113	5.482		Water Body	232.32717	3.159
	Built-Up	579.898618	7.885		Built-Up	1249.0803	16.983

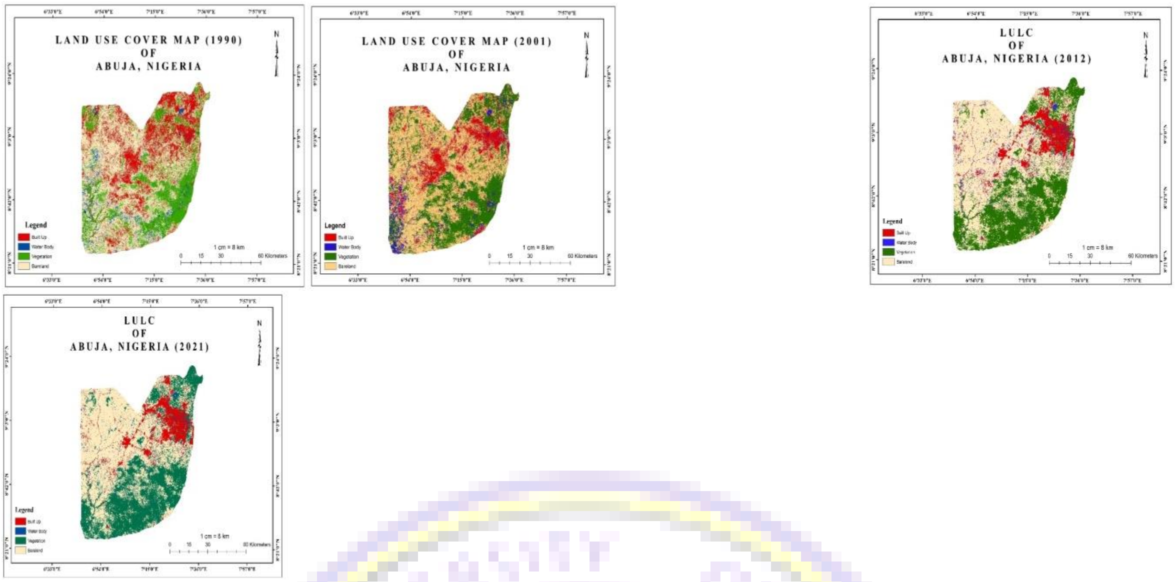
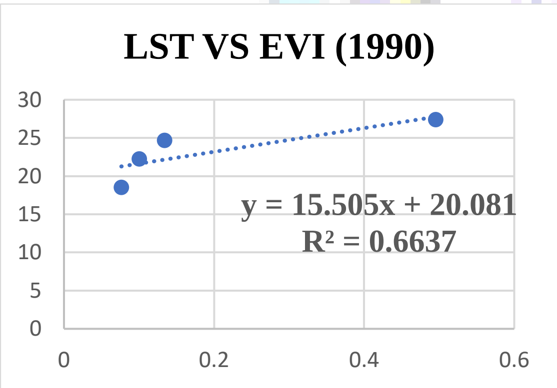
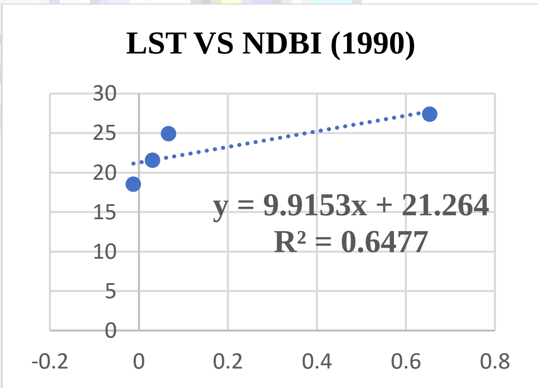


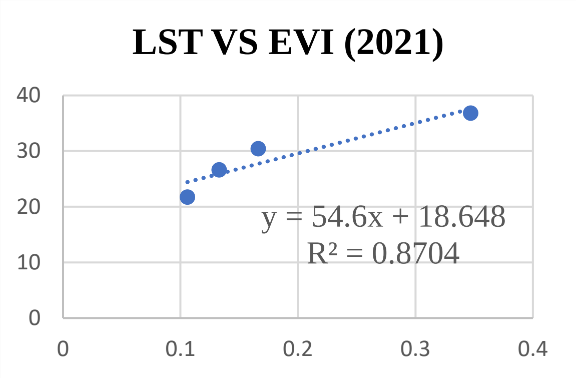
Figure 2. Land use/land cover map of the study area within the last 31 years

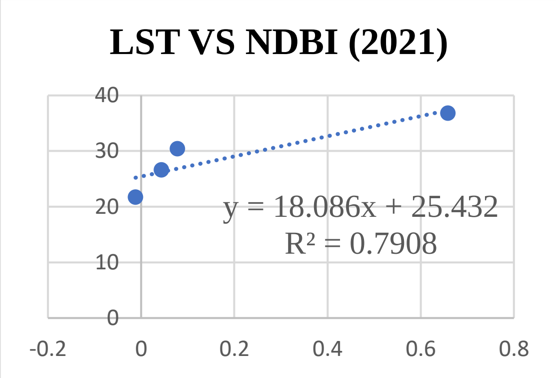
Relationship between LST with NDBI and EVI:

Figure 4 below shows the relationship between the LST, EVI and NDBI with their respective correlation and regression values. Olatunde and Momoh (2019) reported that a strong regression and correlation value (R) depicts a significant relationship between the specified parameters. This Research revealed that there had been a significant relationship between LST and other Indices (EVI and NDBI) since their Correlative values (R) fall between 0.77 to 0.96 and regression (R^2) value within 0.61 to 0.87, which means that temperature in Abuja in the past 31 years had affected Vegetation and Social Infrastructure such as Built-Up.









CONCLUSION

This Research adopted the GIS and Remote Sensing techniques in assessing the implication LST as a driver of Land cover changes and the specified parameters (NDVI, NDBI and EVI) in Abuja. The results obtained from the research are summarized below.

i. Temperature in Abuja in the past 31 years had affected vegetation and social infrastructure such as Built-Up as the correlation value (R) between LST with EVI and NDBI falls within the range of 0.77 to 0.9 and regression value (R^2) within 0.61 to 0.87.

ii. Bare-Land drastically reduced in the last 31 years from 54.628 % to 49.442% in area coverage, while Built-Up had increased from 5.424% to 16.982%. Also, Vegetation decreased between 1990 and 2001 from 34.321 % to 32.905 % and further between 2012 to 2021 between 31.146 % to 30.416 %. Water Body in the study area was stable between 1990 and 2001 but, decreased within 2012 and 2021with a percentile value of 4.560% to 3.15%.

iii. This Research showed that temperature was higher in 2001 and 2021 as both temperature values were above 36^0C which must have resulted in medium or extreme drought. Also, 1990 and 2012 had low temperate values whose temperature were above 27^0C.

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REFERENCE:

Adeyeri, O. E., Okogbue, E. C., Ige, S. O., & Ishola, K. A. (2015). Estimating the Land SurfaceTemperature over Abuja using different Landsat sensors. *Proceedings of the ClimateChange, Environmental Challenges and Sustainable Development*, 305-310.

Anderson, N. H. (1971)."Integration theory and attitude change." Psychological review 78(3): 171.

Dash, P., Göttsche, F. M., Olesen, F. S., & Fischer, H. (2002). Land surface temperature and emissivity estimation from passive sensor data: Theory and practice-current trends. *International Journal of remote sensing*, *23*(13), 2563-2594.

Ikechukwu, M., et al. (2016). "Prediction of Land Surface Temperature (LST) Changes within Ikon City in Nigeria Using Artificial Neural Network (ANN)." International Journal of Remote Sensing Applications 6: 96-107.

Jaber S.M (2019) on the relationship between normalized difference vegetation index and land surface temperature: MODIS-based analysis in a semi-arid to arid environment. Geocarto Int 0(1010–6049):1–19. https:// doi. org/ 10. 1080/ 10106 049. 2019. 16334 21.

Jiang, Z., Huete, A. R., Chen, J., Chen, Y., Li, J., Yan, G., & Zhang, X. (2006). Analysis of NDVI and scaled difference vegetation index retrievals of vegetation fraction. *Remote sensing of environment*, *101*(3), 366-378.

Jiang, Z., Huete, A. R., Kim, Y., & Didan, K. (2007, October). 2-band enhanced vegetation index without a blue band and its application to AVHRR data. In *Remote Sensing and Modeling of Ecosystems for Sustainability IV* (Vol. 6679, pp. 45-53). SPIE.

Macarof, P. and F. Statescu (2017). "Comparasion of NDBI and NDVI as indicators of surface urban heat island effect in landsat 8 imagery: a case study of Iasi." Present Environment and Sustainable Development(2): 141-150.

Matsushita, B., Yang, W., Chen, J., Onda, Y., & Qiu, G. (2007). Sensitivity of the enhanced vegetation index (EVI) and normalized difference vegetation index (NDVI) to topographic effects: a case study in high-density cypress forest. *Sensors*, *7*(11), 2636-2651.

National Population Commission (NPC). 2006 Population and Housing Census: Population Distribution by Age and Sex; Federal Republic of Nigeria: Abuja, Nigeria, 2010.

Olatunde, A. F. and M. Momoh (2019). "Assessment of the relationship between urban growth and surface temperature in Abuja Municipal Area Council." FUDMA Journal of Sciences 3(3).

122 PHOSPHATE MOBILIZATION BY ADDITION OF THREE ANIMAL MANURE SOURCES IN THE SOILS OF KARU, NASARAWA STATE

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Abstract

One mechanism by which plants can mobilize organic and inorganic forms of phosphorus (P) in soils is by exudation of molecular weight organic acids. Screen house trial was carried out in 2021 to study the effects of additions of three levels of animal manures (poultry manure, goat manure and cow dung at 0, 10 and 20 t ha^{-1} on the mobilization of phosphate in soils from Karu, in Nasarawa State. The experimental design used during the screen house trial was Completely Randomized Design (CRD) with three replications and maize was planted as a test crop. Some agronomic, soil Olsen P, and inorganic P data were taken. All data collected were subjected to Analysis of Variance (ANOVA), significantly different means were separated using the Least Significant Difference at 5% level of probability. The results obtained indicated that Olsen – P and NH_4 – P significantly increased by treating with the three organic manures. Al phosphate (Al – P), Fe phosphate (Fe – P), occluded phosphate (Occl – P) and calcium phosphate (Ca – P) were also mobilized and released in various degree irrespective of the organic manure source. The relative fractions of inorganic P was in the order Occl – P > Fe – P > Al – P > Ca – P. The effects of organic manure sources on maize plant height at 4 and 6 weeks after planting was also significant. These three organic manures therefore have the potentials to increase the availability of available P. The practical implication of these processes is that organic residues could be used as a strategic tool to reduce the rates of fertilizer P required for optimum crop growth on P-fixing soils of Nigeria.

Keywords: Molecular weight organic acids, Olsen – P, NH_4 – P, Occl – P

INTRODUCTION

Phosphorus (P) is involved in an array of processes in plants such as photosynthesis, respiration, nitrogen fixation, flowering, fruiting, and maturation (Brady and Weil, 2008; Plaxton and Lambers, 2015). The application of combined organic – inorganic inputs has been one management practice suggested to increase P availability in weathered soils (Agbenin and Igbokwe, 2006). Several researchers have reported the use of several organic materials especially cow dung, poultry droppings, refuse compost, farm yard manure and bio humus as soil amendment substrates, suitable for increasing crop production particularly among subsistence farmers in West Africa (Obire and Akinde, 2004; Adegunloye *et al.*, 2007; Mbonu, 2007).

Phosphate in the soil solution P pool is always available but P amount is very small compared to the amount needed by plants and to the total P in soils. This is because the majority of phosphorus applied to the soil in form of fertilizer becomes fixed and unavailable to plants. Soil pH affects phosphate availability in acid soils. P fixation can be minimized by adjusting soil pH to optimum level (Igwe 2011). P ions can reach larger concentrations in highly fertilized soils, in many soils P concentration in the soil solution is in micro range (between 0.1

and 10 M). They are usually fairly low compared with the adequate P concentration for optimal plant growth. (Hinsinger, 2001).

Already, the widespread occurrence of P deficiency in most arable lands in Nigeria has led to the intensive use of P fertilizer. It has been reported that land utilization also influences P sorption capacity (Odunze, 2009). When phosphorus fertilizers are applied, only a small proportion of it is immediately available to plants. The rest is stored in soils in varying degrees of availability. It is common for farmers to apply phosphorus in excess to make it more available to plants, although this also increases the risk of most phosphorus being lost via run-off, leaching or soil erosion, finally ending up in lakes, rivers and oceans. This represents a financial loss and environmental damage. (Reyes and Michelle, 2012)

Phosphorus deficiency in soil is the most common nutritional stress in many regions of the world, affecting 42 % of the cultivated land in the world. The P deficiency is caused either by low P content in the soils parent materials or by transformations of P added to soils to forms not available to plants. The P deficiency results in poor plant root formation, slow development, poor seed set and fruit formation hence, low and poor crop yields (Khan *et al.*, 2007). Thus, the need arises for specific studies aimed at understanding the effect of some selected organic manure on phosphate mobilization and microbial activities in these soils

MATERIALS AND METHODS

Study Location

The study was conducted in Karu Local Government Area of Nasarawa State. The area falls within the southern Guinea Savanna zone of Nigeria and is located on latitude 9.0267^{O}N and longitude 7.6074^{O}E, with an average annual rainfall of 1469 mm with the highest recorded in the months of July, August and September. The highest temperature of the area is recorded during the dry season when there is little or no cloud cover, it has an annual temperature range between 21^{o}C to 32^{o}C (Udeh, 2010). The geologic features in Karu LGA are founded on basement complex structures that characterize much of the country (Dawam, 2000). The major formation constituting the bedrock includes the combination of different metamorphic and igneous rock formations especially migmatites and muscovite biotic schist having occasional outcrop bands. (Kanayochukwu and Dogo, 2019)

Soil sampling and analysis

Soil samples were collected using the simple random sampling method with an auger from 20 points on the research site at a depth of 0 – 15 cm. The samples collected were then bulked, thoroughly mixed together to form a composite sample which was then analyzed according to the procedures described by IITA (1976). Bouyoucos hydrometer method was used to carry out particle size analysis while textural triangle was used to determine the textural class. The soil pH was measured using glass electrode pH meter and organic carbon by Walkley-Black method. Total Nitrogen was determined using Kjedahl method while Available phosphorus (P) was extracted by Bray P1 method. Exchangeable bases, Ca^{2+}, Mg^{2+}, K^{+} and Na^{+} were extracted with 1N NH4OAc. Ca^{2+} and Mg^{2+} in the extracts were determined using atomic absorption spectrophotometer (AAS) while K^{+} and Na^{+} was determined by flame photometer. Exchangeable acidity was determined by titrimetric titration with standard NaOH. Effective Cation Exchange Capacity was determined by summation method.

Treatments and experimental design

The pot experiment was a 3 x 3 factorial arranged in a Completely Randomized Design (CRD). Treatments were three sources of animal manure (poultry, goat and cow dung) applied in three rates 0-, 5.0- and 10-tons ha^{-1} replicated three times giving a total of 21 pots. Maize was planted as a test crop.

Agronomic practices

Before sowing, 5 kg of soil was thoroughly mixed with different animal manures (poultry, cow dung and goat manure) then put into perforated plastic buckets two weeks before planting. The test crop that was used is maize. Three seeds were planted and later thinned to two per pot. 100 kg N ha^{-1}, 50 kg of single super phosphate ha^{-1}, and 50 kg of muriate of potash (K20) ha^{-1} are the recommended fertilizer rates and were applied in two splits. The first dose (that is 50:50:50 kg ha^{-1}) was applied 2 WAS while the second dose of N (50 kg ha $^{-1}$) was applied at 5 WAS. (Kamara *et al*., 2020).

Growth Parameters

The plant height of maize was measured from the base of the plant to the tip of the plant using meter rule at 2, 4, 6 and 8 weeks after sowing (WAS). Number of leaf was determined by numerical counting of leaves on each plant at 2, 4, 6 and 8 WAS. Leaf area was measured by multiplying the length of the leaf by the breadth then multiplied by the leaf factor. Plants were harvested at 8 WAS. Shoots were cut down at soil level and weighed before and after drying then the readings were subjected to statistical analysis.

Statistical analysis

All data collected were subjected to Analysis of Variance (ANOVA) using genstat 11th edition (2008). Treatment means were compared using least significant difference (LSD) at 5 % Level of probability.

RESULTS AND DISCUSSION

The soil physical and chemical properties before sowing are shown in Table 1. The textural class of the soil was loamy sand. The soil was slightly acidic in water (pH 6.33) and the organic carbon (2.3 g kg^{-1}), with available phosphorus (10.3 mg kg $^{-1}$) was low and high N (1.06 g kg^{-1}) The exchangeable bases was observed to be low and was in the decreasing order Ca > Mg > Na>K. The results obtained on table 2 indicated that Iron phosphate (Fe – P) and Ammonium phosphate (NH_4 – P) significantly increased by treating with the three organic manures but Al phosphate (Al – P), Calcium phosphate (Ca – P) and occluded phosphate (Occl – P) had no significant effect over the control.

Table 1: Physical and chemical properties of the soil used for the experiment

Parameters	Value
Sand (g kg^{-1})	800
Silt (g kg^{-1})	80
Clay (g kg^{-1})	120
Textural Class	Loamy Sand
pH in water 1:2:5	6.33
Organic Carbon (g kg^{-1})	2.3
Total Nitrogen (g kg^{-1})	1.06
Available Phosphorus (mg kg^{-1})	10.3
Exchangeable Bases (cmol kg^{-1})	
Na^+	0.16
K^+	0.06
Mg^{2+}	1
Ca^{2+}	2
Exchangeable Acidity (cmol kg^{-1})	0.11
ECEC	3.33

TABLE 2: Effect of Animal Manure on Maize Plants

Treatment	Al-p	Ca-p	Fe-p	NH4cl-p	Occl-p	Total P
PM 5 t/ha^{-1}	17.65	9.97	17.42	18.62	25.06	36.0
PM 10 t/ha^{-1}	16.60	8.56	17.72	16.10	30.39	31.7
GM 5 t/ha^{-1}	18.58	9.58	19.49	19.57	22.43	28.7
GM 10 t/ha^{-1}	17.39	7.40	19.41	18.65	28.22	27.3
CD 5 t/ha^{-1}	19.39	9.56	19.68	19.36	20.99	32.0
CD 10 t/ha^{-1}	16.69	7.55	20.56	18.18	24.07	32.3
Control	20.07	9.94	22.39	20.50	18.85	34.0
LSD	0.79	0.68	0.99	0.78	0.93	1.94

CONCLUSION AND RECOMMENDATION

These three organic manures; the poultry manure, goat manure and cow dung therefore have the potentials to increase the availability of P. The practical implication of these processes is that organic residues could be used as a strategic tool to reduce the rates of fertilizer P required for optimum crop growth on the soils of Karu. A field trial should be conducted to ascertain this finding.

REFERENCES

Adegunloye, D. V., Adetuyi, F. C., Akinyosoye, F. A., and Doyeni, M. O. (2007). Microbial analysis of compost using cow dung as booster. *Pakistan Journal of Nutrition* 6(5):506-510.

Agbenin, J. O and Igbokwe, S. O. (2006). Effect of soil-dung manure incubation on the solubility and retention of applied phosphate by a weathered tropical semi-arid soil. *Geoderma* 133: 191–203

Brady, N. C. and Weil, R. R. (2008). The nature and properties of soil, 14 ed. *Prentice-Hall, Upper Saddle River, New Jersey.*

Dawan, P. D. (2000). The Geography of Abuja Federal Capital Territory. *Famous / Asanlu Publishers, Minna.*

Genstat (2008). Genstat for Windows, Release 11.1.0.1575. 11th Edition, VSN International Ltd., Oxford.

Hinsinger, P. (2001). Bioavalability of soil inorganic P in the rhizosphere as affected by root induced chemical changes: *a review*. *Plant and Soil* 237: 173 – 195

Igwe, C. A. (2011). Free oxide distribution in Nigeria flood plain soils in relation to their total and available phosphorus. *Proceedings of the 27th annual conference of the soil science society of Nigeria*, PP:201 Obire, O. and Akinde, S. B. (2004). Poultry manure amendments of oil polluted agronomic soils for sustainable development in the Niger Delta. *Journal of Nigeria Environmental Society* 2(2):138-143.

IITA. 1976. Selected methods for soil and plant analysis. IITA, Ibadan – Nigeria. Manual series No 1. Pp 70

Kamara, A. Y., Kamai, N., Omoigui, L. O., Togola, A., and Onyibe. J. E. 2020. Guide to Maize Production in Northern Nigeria: lbadan, Nigeria. 18 pp.

Kanayochukwu, E. and Dogo, B. (2019). Profiling the Characteristics of Karu Slum, Nasarawa State, Nigeria. *Journal of Service Science and Management*, 12, 605-619.

Khan, M. S., Zaidi, A. and Wani, P. A. (2007). Role of phosphate- solubilizing microorganisms in suistainable Agriculture – *A Review*. *Agronomy for Sustainable Development*, Vol.27, No.1, pp 29 – 43

Mbonu, O. A. (2007). Effect of Earthworm activity and Organic residues on the Physical properties of a compacted ultisol. *PhD Thesis RSUST Port Harcourt*.

Obire, O. and Akinde, S. B. (2004). Poultry manure amendments of oil polluted agronomic soils for sustainable development in the Niger Delta. *Journal of Nigeria Environmental Society* 2(2):138-143.

Odunze, A. C. (2009). Land use limitation and management option for a savanna zone Alfisol. *Journal of Agriculture and Environment for International Development*. 103 (4): 321 – 335.

Plaxton, W. C. and Lambers, H. (2015). Phosphorus Metabolism in Plants. *Wiley-Blackwell*. https://doi.org/10.1002/9781118958841

Reyes, T. and Michelle, A. (2012). Phosphorus in Agriculture: Problems and solutions. *Greenpeace Research Laboratories Technical Report* (Review), JN 416 (P)

Udeh, A. U. (2010). Impact of Development of the Federal Capital City, Abuja on Selected Settlements in Karu Local Government Area, Nasarawa State, Nigeria.

123 COMBINATION OF ORGANIC MANURE, INORGANIC FERTILIZER AND BIO-FERTILIZER ON SOYBEAN [(Glycine max l. (merril)] GROWTH

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Abstract:
Inherent low soil fertility improvement and crop productivity enhancement can be attributed to the addition of organic materials which has been identified as an alternative approach to the use of chemical fertilizer. Field studies were conducted on CSIR Savanna Agricultural Research Farm at Nyankpala and on farmer's field at Cheshegu and Ghulahgu all in Tamale, Northern region of Ghana. To ascertain the effects of combining organic manure (30 t ha^{-1}), inorganic fertilizer (25: 30: 30 kg ha^{-1} NPK) and inoculation with Bradyrhizobium japonicum (5 g per seed) and control. The experiment was laid out in a randomized complete block design (RCBD), replicated four times. Data were collected on number of nodule, nodule weight, biomass accumulation and grain yield. Parameters were analyzed using GenStat statistical package (11th edition) at P<0.05 level of significance. Results obtained revealed significant (P<0.05) soybean nodulation, biomass accumulation and grain yield responses to the combination of organic manure (Fertisoil (FS)) + inorganic fertilizer (25:30:30 kg ha^{-1} NPK), organic manure (FS) + Inoculation (INO), inorganic fertilizer (NPK) + Inoculation (INO), FS+NPK and of course sole use of FS as compare to the sole use of NPK, INO and especially the Control. Though there were significant (P<0.05) differences observed in favor of some of the treatment combinations as compare to the sole applications with respect to the different locations, however, the trend of soybean response to soil amendments across the different locations were similar. Hence, the confirmation of the fact that for soybean growth and yield improvement in Northern Ghana, suitable and affordable soil and seed amendments by farmer's at different locations within the same agro-climatology are numerous.

INTRODUCTION:

Ghana has the potential of increasing her soybean production and reduce imports from the US and Brazil and even export some to neighboring West African countries for foreign exchange, if small scale and commercial farmers step up their productivity using improved agronomic practices (MOFA, 2006; Mbanya, 2011). There is no doubt that so many researchers have carried out a lot of improved agronomic practices on soybean production enhancement

(Ezekiel-Adewoyin *et al.*, 2014; 2017 Lambon, 2016; Rurangwa *et al.*, 2018) in the northern region of Ghana. However, for holistic and specific authentication of soil fertility recommendation. Research findings needs to be repeated at least twice to corroborate previous observations. The nature of soil (heterogeneity) influences soil performance and it’s response to soil fertility amendments, hence, to combat soil non-responsive characteristics there is need to combine the different soil nutrient resources in a system refer to as integrated soil fertility management (ISFM), for the confirmed limitations in each resources to be taken care of by one another.

MATERIALS AND METHODS:

Experimental site:

Three separate field experiments located at Cheshegu, Ghulahgu and Akukayili were conducted during the 2013 planting season. Ghulahgu is located on latitude 07° 24’ 14.3’’ N and longitude 00° 37’ 20.0’’ W at an elevation of 167 m above mean sea level whiles Akukayili and Cheshegu are located on latitude 09° 23’22.4’’ N and longitude 01° 00’ 12.1’’ W, at an elevation of 195 m above sea level and on latitude 09° 27’ 17.3’’ N, and longitude 00° 57’ 23.0’’ W at an elevation of 187 m above mean sea level, respectively. The annual rainfall during the cropping season was 1200 mm with mean minimum and maximum temperature of 26 °C and 39 °C, respectively. The soils of Akukayili, Cheshegu and Ghulahgu are classified by FAO, (1988) as Ferric Luvisoil, Gleyic Luvisoil, and Lixic Pinthosol, respectively. Most inhabitants of the study area are peasant farmers who carry out farming activities year in year out as their major source of livelihood.

Field description, soil sampling and chemical analyses:

Fields of unknown history of soybean cultivation and Bradyrhizobium inoculation were chosen. Soil samples were randomly collected from each of the experimental fields at a depth of 0 to 15 cm with the use of soil auger. The soils were bulked, air dried, sieved with 2 mm diameter mesh and analyzed for its physical and chemical properties from each field as follows; Soil pH was measured in the supernatant suspension of 1:2.5 soil:water mixture by pH meter. Soil organic carbon was determined by Walkley and Black method (Walkley and Black, 1934). Total nitrogen was determined by Kjeldahl procedure. Available phosphorus determined by Bray 1 procedure (Bray and Kurtz, 1945; Olsen and Sommers, 1982) and soil texture was determined following Bouyocous hydrometer method. The estimation of rhizobia populations in the study area were carried out using the most probable number method (MPN) according to Vincent (1970).

Sowing was done on ridges at a distance of 75cm between ridges and 50cm within ridges. To avoid contamination of the un-inoculated treatments with the inoculants that might get stuck to the hand during sowing, the un-inoculated seeds were sown before the inoculated ones. The plants were allowed to grow to maturity under rain-fed conditions while the recommended management practices like supplying, thinning, weeding etc were observed.

Treatment, layout and experimental design:

The following treatments were used; Organic manure fertisol (0 and 3 tons ha^{-1}), inorganic fertilizer; Ammonium sulphate at the rate of 25 kg ha^{-1} and (30 kg P_2O_5 ha^{-1}, muriate of potash of 30 kg K_20 ha^{-1} were used as basal application and *Bradyrhizobium japonicum* (+ and -). The land was ploughed, harrowed and ridged; in order to allow easy uprooting of the nodules, plots were 7 m long and 7 m wide. The soil was amended with organic manure (Fertisoil) two weeks before planting while the inorganic fertilizer was applied two weeks after planting and the inoculant was applied at planting. Planting was done by dibbling (2 seeds per hill) and later thinned to one per hill. The design was Randomized Complete Block Design arranged in Randomized Complete Block Design replicated four times.

Data collection

Nodule count, nodule dry weight and shoot biomass yield

In the assessment of nodulation and shoot biomass, ten plants were randomly selected and sampled at 50% flowering by carefully pulling them out of the ground after loosening the soil around the plants gently on each field. The detached nodules from the roots in the process of uprooting are ensured collected. The shoots from each plot /field were then separated from the root system, bulked and weighed on a digital scale, after which they were air-dried for one day, followed by oven-drying at 75°C for 48h (to a constant weight) and the weights recorded. The nodules were detached from the roots and carefully washed using sieve, counted, weighed and then oven-dried at 75°C for 48 h and dry weights were recorded.

Number of pods, pod weight and grain yield

At maturity, all the pods from the plants of the two innermost ridges of each plot were harvested manually and counted after which they were oven-drying at 75°C for 48 h and weighed on a digital scale. The dried pods were threshed and winnowed to separate the grains from the husk and the former weighed to obtain the grain yield. Then hundred seeds were selected according to the treatments applied, weighed and recorded.

Data analysis

Data were statistically analyzed using GENSTAT 11th edition. The analysis of variance (ANOVA) while the significant means were separated using the Least Significance Difference (LSD) at 5% level of probability (Gomez and Gomez, 1984). Number of nodule counted was transformed.

RESULTS AND DISCUSSION:

Soil chemical properties determined in the study area before the commencement of the experiment showed that generally the soil fertility status is below the optimum recommended rate for most plants (pH 5.5, 5.8 and 4.7 for Akukayili, Cheshegu and Ghulahgu respectively). Across locations, the organic carbon (< 20 g kg^{-1}), total nitrogen (< 1 g kg^{-1}), exchangeable cations (< 5 cmol $_{(+)}$ kg^{-1}), effective cation exchange capacity (< 5 cmol $_{(+)}$ kg^{-1}) and extractable P (< 10 mg kg^{-1}) were low. The physical analysis showed that the soil is sandy loam at Akukayili and Cheshegu but silty loam at Ghulahgu (Table 1). The Most Probable Number of Bradyrhizobia determined shows that the native rhizobia populations are 6.3×10^1, 5.5×10^1 and 5.8×10^1 for Akukayili, Cheshegu and Ghulahgu respectively.

Effect of treatments on soybean nodulation:

Soybean response to the various treatments used with respect to nodule formation and its dry weight across location were inconsistent. The combination of FS+NPK+INO resulted in the highest nodule number at Akukayili while at Cheshegu and Ghulahgu, INO (27) and NPK+INO (344) gave the highest. However the treatment with the highest number of nodules were not significantly different from NPK+INO and FS+INO at Akukayili, Control and FS+NPK at Cheshegu, and FS+INO and FS+NPK+INO at Ghulahgu. Generally the response of soybean nodule to the applied treatments was better at Ghulahgu compare to the other locations. Also the sole nutrient application response followed the same trend across location with the control plots. The nodule weight also had the same pattern of response similar to that of the nodule number, were Ghulahgu soil positively responded to the applied treatments than at Akukayili and Cheshegu. The treatments with the highest nodule number translated it to the soybean nodule weight except at Ghulahgu were FS+INO and FS+NPK recorded the heaviest weight of nodule than NPK+INO.

Effect of treatments on soybean shoot biomass and grain yield:

The biomass yield as shown on Figure 1 reflects that generally Ghulahgu soil positively responded to the applied treatments which then favors the biomass accumulation. FS+INO recorded the highest biomass weight of 3996 and 2652 kg ha^{-1} at Akukayili and Cheshegu while

FS+NPK had 5228 kg ha^{-1} at Ghulahgu. However the highest biomass produced treatment was at par with FS+NPK+INO and FS+NPK at Akukayili. At Cheshegu the highest produced treatment was at par with FS+NPK while at Ghulahgu it was at par with sole FS. The sole application of the treatments used recorded biomass yield not significantly different from the control except with FS at Ghulahgu.

The grain yield of soybean gotten from Ghulahgu field again showed similar trend to the other parameters that had been observed earlier. And the trend of response to the applied treatments across the locations were also similar to that observed in relation to other parameters. Whereby the sole application of INO, NPK and FS performed at par with the Control. The treatment combination performance were also similar. FS+NPK+INO recorded 3334 kg ha^{-1} grain yield which was not significantly different from FS+NPK (3210 kg ha^{-1}), Also at Cheshegu FS+NPK+INO also recorded the highest grain yield of 3006 kg ha^{-1} which was at par with the grain yield from plots amended with FS+NPK and next was 2674 kg ha^{-1} produced from plot treated with FS+INO. At Ghulahgu FS+NPK recorded the highest grain yield of 3542 kg ha^{-1} and was significantly at par with the grain yield gotten from the plots amended with FS+NPK+INO and FS+INO which recorded 3294 and 3224 kg ha^{-1} respectively.

CONCLUSION:

The observation from this experiment reveals that indeed the combination of the various soil and seed amendments (organic manure + inorganic fertilizer + Inoculation) actually enhanced the growth and yield of soybean in the study areas compared to the sole application of the various treatments except the sole use of fertisoil (organic manure) hence it is recommended that farmers can used the different combination of treatments to improve soybean growth and obviously the yield. Also the use of fertisoil alone can also be exploited.

Table 1: Initial soil analysis of the different experimental sites

Soil property	Akukayili	Cheshegu	Ghulahgu
pH (1:2.5 H_20)	5.5	5.8	4.7
Organic carbon (%)	0.7	0.7	0.5
Total N (%)	0.3	0.3	0.2
Extractable P (mg kg^{-1})	7.4	6.3	2.3
Ca ($cmol_{(+)}kg^{-1}$)	2.92	3.50	2.56
Mg ($cmol_{(+)}kg^{-1}$)	0.65	0.43	0.50
K ($cmol_{(+)}kg^{-1}$)	0.09	0.06	0.30
Na ($cmol_{(+)}kg^{-1}$)	0.05	0.18	0.36
Bulk density (g cm^3)	1.38	1.40	1.46
Moisture content (%)	40.00	39.00	45.00
Texture	Sandy loam	Sandy loam	Silty loam
MPN (cells g^{-1} soil)	$6.3×10^1$	$5.5×10^1$	$5.8 × 10^1$

Table 2: Effect of organic manure (fertisoil), inorganic and inoculation on soybean nodulation

Treatment	AKUKAYILI Nod. No. per $^{-1}$	AKUKAYILI Nod. dry w mg $plant^{-1}$	CHESHEGU Nod. No. per $^{-1}$	CHESHEGU Nod. dry w mg $plant^{-1}$	GHULAHGU Nod. No. per $^{-1}$	GHULAHGU Nod. dry w mg $plant^{-1}$
INO	26	55.0	27	185.0	195	1100
CONTROL	14	45.0	24	68.5	50	325
NPK	14	57.5	21	105.0	57	325
FS	15	75.0	14	71.5	101	625
NPK+INO	40	77.5	11	77.5	344	1275
FS+NPK	20	105.0	23	116.5	144	2000
FS+NPK+INO	42	105.0	15	70.5	231	1525
FS+INO	31	77.5	16	59.0	268	2050
LSD (0.05)	100.68	47.59	12.00	50.00	180.5	582.8

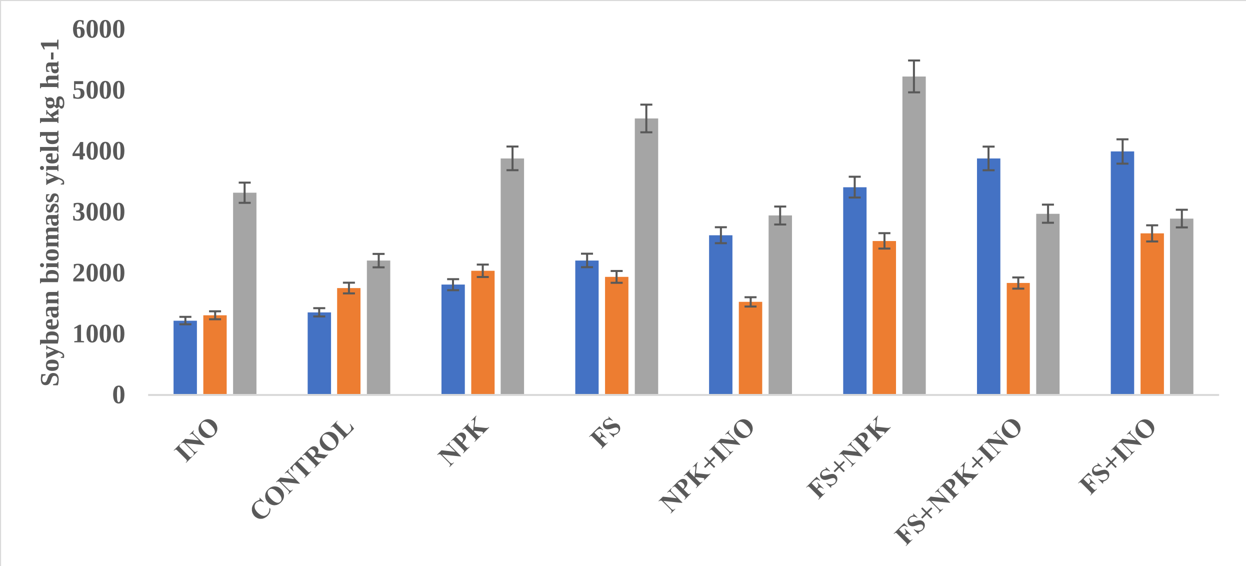

Fig. 1: Effect of organic manure, inorganic and inoculation on soybean biomass yield at the three locations

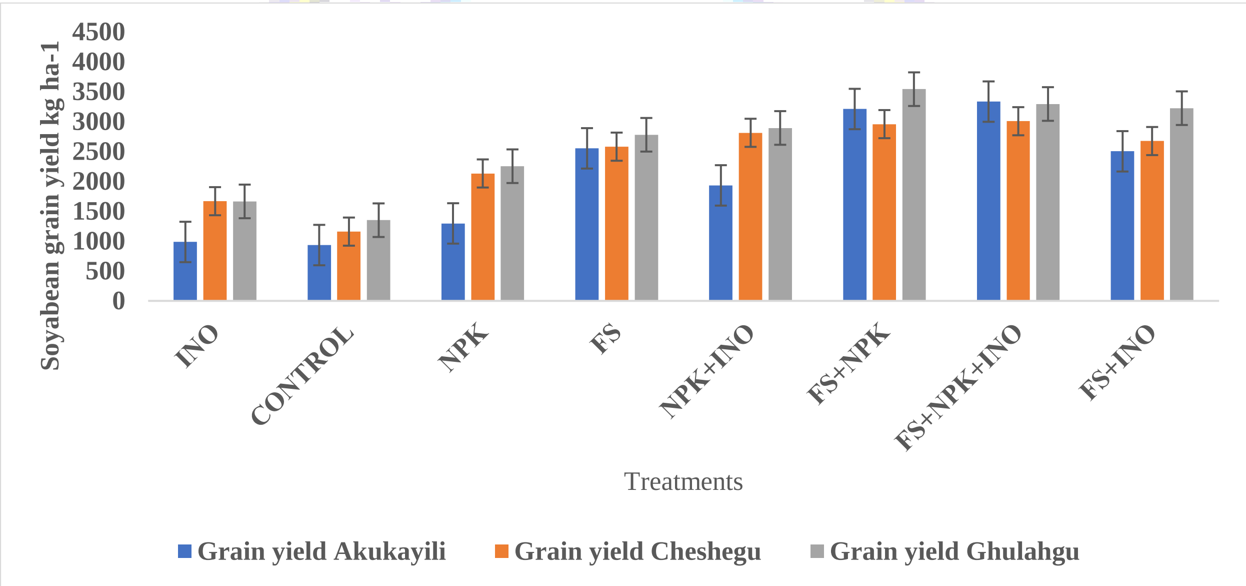

Fig. 2: Effect of organic manure, inorganic and inoculation on soybean grain yield at the three locations

REFERENCES:

Bray, R.H., Kurtz L.T. (1945). Determination of total, organic and available forms of phosphorus in soils. Soil Sci, 59: 39-46.

D.T. Ezekiel–Adewoyin (2014). Evaluation of the growth response of soybean (*glycine max* l.) to some commercial fertilizers in the guinea savannah agro - ecological zone of Ghana. PhD thesis, University of Science and Technology (KNUST), Kumasi, Ghana.

D.T. Ezekiel–Adewoyin, Nana Ewusi-Mensah, Olufemi Ayanfe Oluwafemi, David Ogunleti, Adenike Adekunle and Christiana Kayode. (2017) Nodulation, growth and yield response of soybean [(Glycine max l. (merril)] to inoculum (Bradyrhizobium japonicum) under phosphorus levels and compost amendment in Northern Ghana. Net Journal of Agricultural Science Vol. 5(4), pp. 141-150, November 2017 ISSN: 2315-9766.

FAO. (1988). *Soil Map of the World. Revised Legend*. Reprinted with corrections. World Soil Resources Report 60. FAO, Rome

J.B. Lambon (2016). Inoculation and n fertilizer effects on the growth, grain yield and n remobilization in soybean (Gylcine max [l] merrill) in the Guinea Savanna zone of Ghana.

Mbanya, W. (2011). Assessment of the Constraints in Soybean Production: A Case of Northern Region, Ghana. Journal of Developments in Sustainable Agriculture 6: 199-214.

MoFA (Ministry of Food and Agriculture), (2006). Agricultural Extension Handbook. Ministry of Food and Agriculture, Accra, Ghana. Deutshe Gesellshaft fur Internationale Zusammenarbeit (GTZ)/Ministry of Food and Agriculture/AgricultureSub Sector Investment Project & Canadian International Development Agency/Farmer Responsive Mechanisms in Extension and Research Project, Ghana. pp. 23-241.

Olsen, S.R., Sommers L.E. (1982). Phosphorus. In; A.L. Page (eds.). Methods of soil analysis. Part 2. Chemical and microbiological properties. Second edition. American.

Rurangwa, E., Vanlauwe, B., and Giller, K. E. (2018). Benefits of inoculation, P fertilizer and manure on yields of common bean and soybean also increase yield of subsequent maize. Agric. Ecosyst. Environ. 261, 219–229. doi: 10.1016/j.agee.2017.08.015.

Rurangwa, E., Vanlauwe, B., and Giller, K.E. (2018). Benefits of inoculation, P fertilizer and manure on yields of common bean and soybean also increase yield of subsequent maize. Agric. Ecosyst. Environ. 261, 219–229. doi: 10.1016/j.agee.2017.08.015.

Vincent J.M., (1970). A manual for the practical study of root nodule – bacterial. Blackwell Scientific Publications. Oxford. In: Influence of the size of indigenous rhizobial population on establishment and symbiotic performance of introduced rhizobia on field-grown legumes by Thies JE, Singleton PW, Bohlool BB, 1991. Appl Environ Microbiol, 38: 493–500.

Walkley, A, Black I.A. (1934). An examination of the degtjareff method for determining soil organic matter and proposed modification of the chromic and titration method. Soil Sci, 37: 29-38.

124 SPATIOTEMPORAL ASSESSMENT OF THE DYNAMICS OF DROUGHT IN NORTHEAST NIGERIA USING REMOTE SENSING TECHNIQUES

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Abstract:
Nigeria is faced with rapid desert encroachment affecting mostly the North-Eastern part of the country. Drought has cost the Populace in the North-Eastern part of Nigeria their social infrastructure, lives, agricultural practice, health, and properties as a result of Natural factors (shortage of rainfall). The aim of this research is to assess the drought in the North-Eastern part of Nigeria (Borno, Adamawa, and Yobe state) through the following objectives; Land Surface Temperature (LST), Normalized difference drought index (NDDI) and Vegetation Condition Index (VCI) indices. GIS and Remote sensing techniques were adopted in acquiring Landsat 7 images of 2010 and Landsat 8 images for the years 2013, 2018 and 2021. The Land use/Land cover of the study area was assessed in other to fully address prone features to the drought, the Normalized difference drought index (NDDI) and Vegetation Condition Index (VCI) indices were assessed using the bands 2,3,4,5 while the Land Surface Temperature (LST) was estimated using the band 6 for Landsat 7 and band 10 for Landsat 8. Within the 11-year period, investigation of the NDDI index depicted a moderate trend of drought in 2013, 2018 and 2021, while the LST result indicated a high effect of surface temperature in 2010, 2013, 2018 and moderate in 2021. Similarly, the VCI showed a high result of vegetation in the study area for the years 2010 and 2013, moderate in 2018 while it showed a low result for the year 2021. This research showed the effect of drought in the study area had increase thoroughly over the last 11 years, which as a result had severe effect on water bodies, bare land, domestic lives and activities of the habitants of the area.

Keywords: drought, Normalized Difference Drought Index (NDDI), Land Surface Temperature (LST), Vegetation Condition Index (VCI).

Introduction

Drought is a natural hazard that involves many factors, including meteorological and climatological parameters, having complex inter-relationships. Drought definitions vary from region to region and may depend upon the dominating perception and the task for which it is defined (Tsakiris et al., 2007). Van Loon and Laaha (2014) simply defined drought as 'below normal availability of water'. Also defined by Yaduvanshi et al., (2015) as prolonged shortages of surface and sub-surface water which affect the functioning of ecosystems. Drought is a global challenge being faced by many developed and developing Nations. Nigeria is faced with rapid desert encroachment affecting fifteen northernmost states from moderate to severe rates. Out of the 909,890 km² of the country's land area, about 580,841 km², accounting for 63.83% of total land, is impinged on by desertification which is caused by drought (Olagunju 2015). Drought is caused in both natural and manmade ways. The natural causes include reduced rainfall and global warming, while the human causes or manmade causes are overpopulation, over-cultivation, over-extraction, deforestation for industrial purposes or fuel wood, urbanization, bush burning, agro-activities on marginal lands and other sustainable agricultural activities (Olagunju 2015).

Nigeria is one of the countries being affected by drought in Africa, with notable effects on the Northern part of the country. Drought phenomenon has been reported in Northern Nigeria since the 1920s, but the impact has been more glaring since the famine of 1971 to 1973 (Olagunju 2015). Drought affects fifteen northernmost states of the country, and almost one-fifth of the total Nigeria land area is affected (Jaiyeoba, 2002).

Climate change perhaps is one of the greatest challenges facing our planet today, with North East Nigeria witnessing a rapid drought as a result of several factors such as decrease in rainfall amount, deforestation, urbanization etc. These changes may affect Man daily activities, Agricultural practice, vital ecosystem, lead to decimation of habitats, affect other water dependent activities, trigger migration etc. More Human beings, Crops, Animals and Agricultural practices will be severely affected by drought if not properly monitored and treated seriously. Regions affected with insecurities cannot just be neglected, therefore, there is need to employ Remote Sensing techniques in tackling, studying, forecasting and identifying pattern of drought in Northeast Nigeria, as it is an important means in monitoring of natural hazard in places not easily accessible with conventional ground methods.

Study Area

Nigeria is divided into six geopolitical zones consisting of North Central which comprises of seven States, North East consist of six State, North-West with seven State, South-East with five States, South-South consist of six States, and South-West comprises of six States. Figure 1 is a map indicating the study area as Adamawa, Bauchi, Borno, Gombe, Taraba and Yobe states made up the North East Nigeria. This research focuses on Borno, Adamawa and Yobe State (BAY STATE).

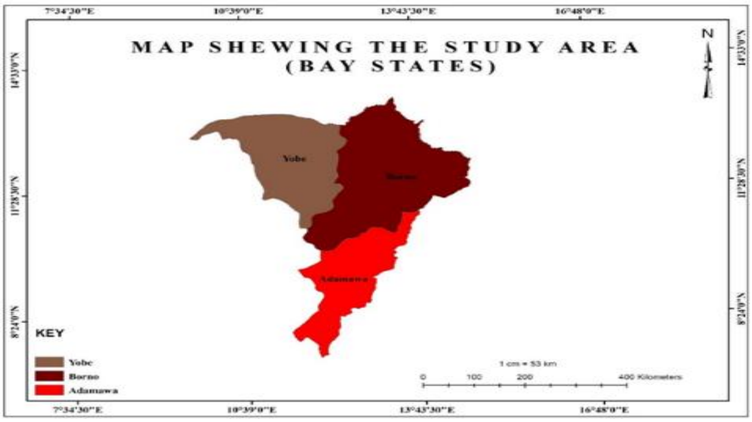


Fig. 1. Study Area (Borno, Adamawa and Yobe States)

METERIALS AND METHOD

Materials

Table 1 shows the full data used in this research, the data were acquired on different days and from different sources as indicated in the table.

Table 1. Data acquired for the Research

S/N	Dataset	Scale/ Resolution	Source-78866666666666666666666666666666629.000000000000000	C oordinate System	Acquisition Date
1	Nigeria Shapefile		Diva-GIS (https://www.diva-gis.org/gdata.)	GCS_WGS1984 UTM Zone 31N	10th Of AUGUST, 2021.
2	Landsat 8 Imagery - Operational Land Imager (OLI) Path/Row – 184/52, 185/51, 185/52, 185/53, 185/54, 185/55, 186/51, 186/52, 186/53, 186/54, 186/55, 187/51, 187/52, 188/51	30m x 30m	NASA/USGS https://earthexplorer.usgs.gov/	GCS_WGS1984 UTM Zone 31N	4th of September, 2021.
3	+Landsat 7 Imagery – L1TP_ Path/Row – 184/52, 185/51, 185/52, 185/53, 185/54, 185/55, 186/51, 186/52, 186/53, 186/54, 186/55, 187/51, 187/52, 188/51	30m x 30m	NASA/USGS https://earthexplorer.usgs.gov/	GCS_WGS1984 UTM Zone 31N	6th of September, 2021.

Methods

Land use cover

The land use cover of the study area was carried out in other to observe the effect of the Drought on different sectors within the study area. The acquired Landsat 7 and 8 imageries were imported into the ArcMap environment, and band composite was finally carried out on the imagery with bands 6, 5,4 combinations for Landsat 8 and 5,4,3 for Landsat 7. Image enhancement was carried out on the composite image and the fourteen imageries for each year were merged together, the study area was clipped out from the merged Landsat 7 and 8 imageries. Maximum likelihood supervised classification was then applied to the clipped imagery in the ArcMap environment mapping four major classes such as Built-up, Bare land, Vegetation, Water body, using the Classification Scheme deduced by Anderson (1971), the training sites were created by using the polygon tool in the image classification toolbar in the ArcMap environment.

Indices maps

The NDVI for the year 2010, 2013, 2018 and 2021 was calculated using the equation (1) by Rouse et al. (1973);

$$NDVI=\frac{NIR-RED}{NIR+RED} \qquad (1)$$

The band 4 & 5 of Landsat 8 and band 3 & 4 of Landsat 7 was used to carry out the NDVI, after which the Bands had been mosaic and clipped, the above formular was then applied. The equation (2) by Gao 1996 was used for NDWI calculation for years 2010, 2013, 2018 and 2021.

$$NDWI=\frac{(NIR-SWIR)}{(NIR+SWIR)} \qquad (2)$$

The band 3 & 5 of Landsat 8 and band 2 & 4 of Landsat 7 was used to carry out the NDWI, after which the Bands had been mosaic and clipped, the equation 2 above was then applied. The NDDI for the year 2010, 2013, 2018 and 2021 was calculated using the equation (3) by (Renza et al 2010);

$$NDDI=\frac{(NDVI-NDWI)}{(NDVI+NDWI)} \qquad (3)$$

The processed NDVI and NDWI was run in the Raster Calculator in the ArcMap environment. The LST was carried out having estimated the Top of Atmosphere (TOA) using equation (4), the TOA was converted to brightness temperature (BT) with the application of equation (5), the Proportion of vegetation (PV) was then observed with the equation (6), finally, all the above process were adopted to estimate the LST of the study area using equation (7).

$L\lambda = ML * Qcal + AL - O_i$ (Kumar and Shekhar, 2015) ……………………………………..(4)

BT: (1321.0789 / Ln(774.8853 / "TOA" + 1)) - 273.15 Rajani and Varadarajan (2021) …....(5)

$PV = ((NDVI - NDVI_{min}) / (NDVI_{max} - NDVI_{min}))^2$ Kumar and Shekhar (2015) …………..(6)

$LST = [BT / (1+\lambda * BT/c2) * Ln(\mathcal{E})]$ Kumar and Shekhar (2015) ……………………….…….(7)

Finally, Kogan (1990) equation was adopted for the VCI calculation for the years of the study (2010, 2013, 2018 and 2021).

$$VCI_i = \frac{NDVI_i - NDVI_{min}}{NDVI_{max} - NDVI_{min}} \text{ x100} \quad \text{………………………………...…………………(8)}$$

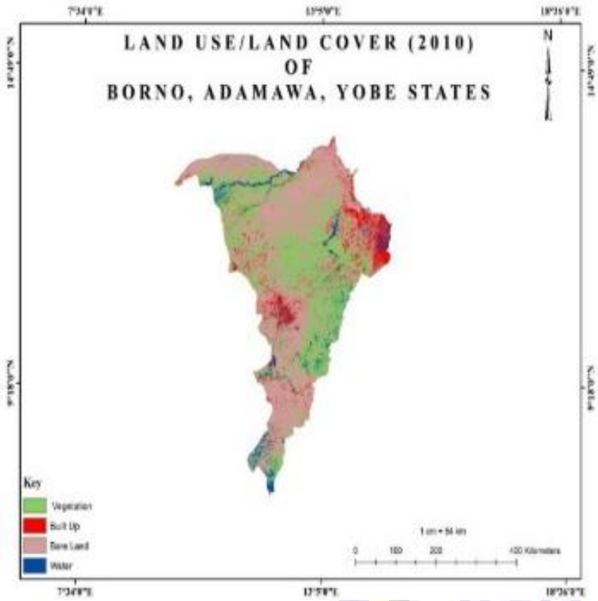
Results and Discussion

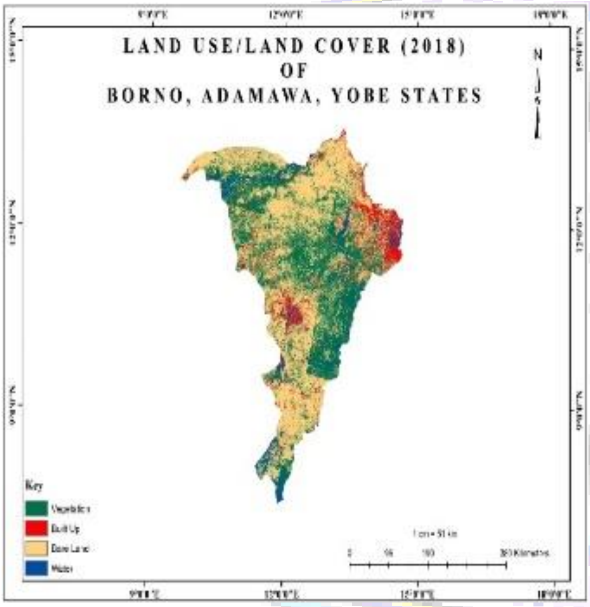
Land use cover

Table 2 is the land cover change of the study area within an epoch of ten years. This indicated that built-up and bare land had increased within the last ten years while water bodies and vegetation such as thick and light forests had decreased within the last ten years. While figure 2 shows the land use/land cover map of the study area within the last ten years.

Table 2. Land Use/Land Cover changes for the year 2010, 2013, 2018 and 2021.

Year	Built Up (%)	Bare Land (%)	Vegetation (%)	Water Body (%)
2010	15.27	36.82	33.48	14.43
2013	18.50	37.99	29.53	13.98
2018	25.63	45.50	18.67	10.20
2021	37.12	43.33	11.86	7.69


LAND USE/LAND COVER (2010)
OF
BORNO, ADAMAWA, YOBE STATES
N
Key
Vegetation
Built Up
Bare Land
Water


LAND USE/LAND COVER (2018)
OF
BORNO, ADAMAWA, YOBE STATES
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Key
Vegetation
Built Up
Bare Land
Water

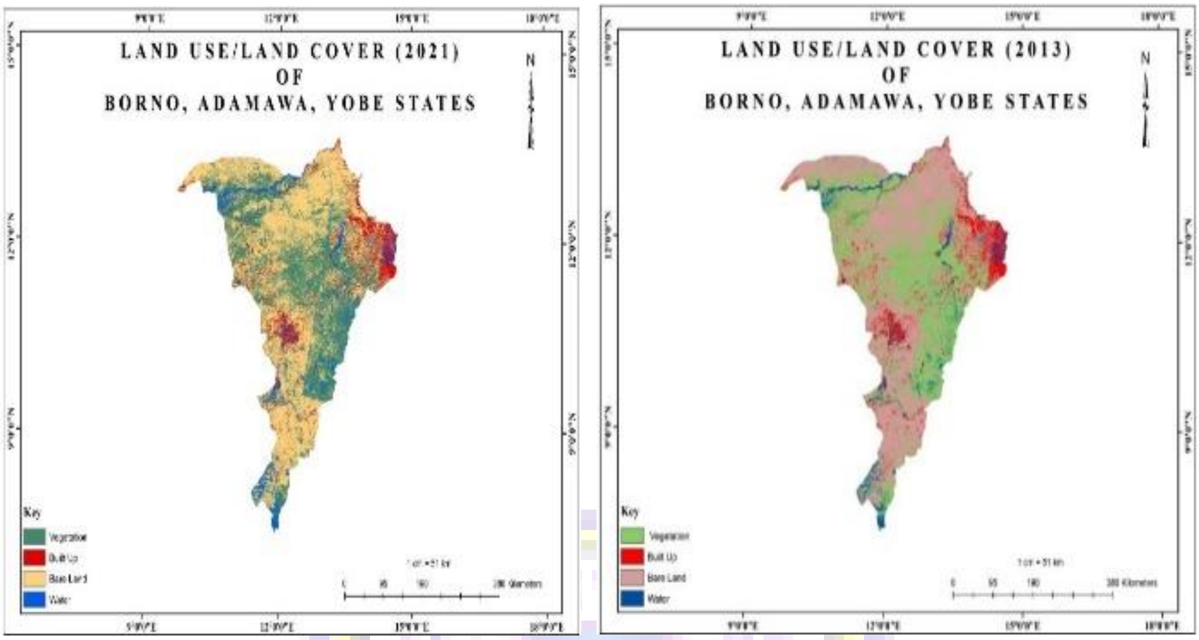


Figure 2. Land use/land cover map of the study area within the last 10 years.

Indices maps

NDDI: table 3 indicates the NDDI results of the study area within an epoch of ten years and figure 3. It represents the NDDI map of the study area within the last 10 years. Dobri et al. (2021) reported that the resulting values of the NDDI range generally from 0 (no drought) to >1.0 (extreme drought).

Table 3. NDDI values for the year 2010, 2013, 2018 and 2021

YEARS	NDDI values	Indication	Affected sector
2010	-0.95 – 0.53	Very Low Drought Condition	Water, Vegetation, and Built up
2013	-0.8 – 0.6	Medium Drought Condition	Built Up and Vegetation
2018	-0.9 – 0.7	Extreme Drought Condition	Vegetation, and Water bodies
2021	-0.6 – 0.4	Low Drought Condition	Vegetation and Bare land

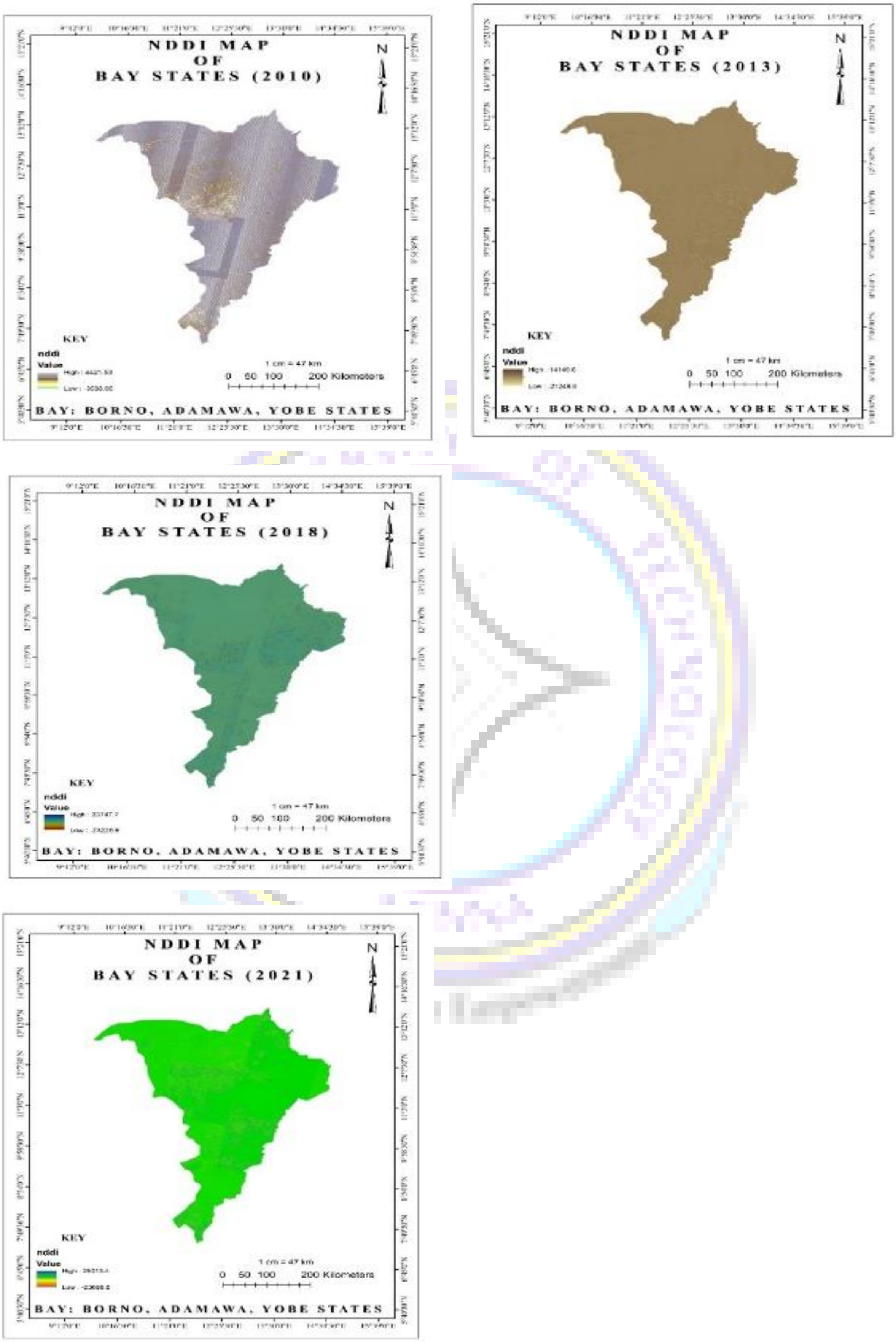
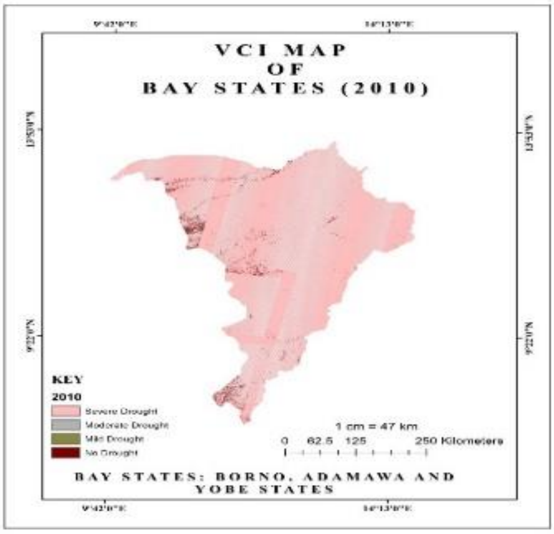


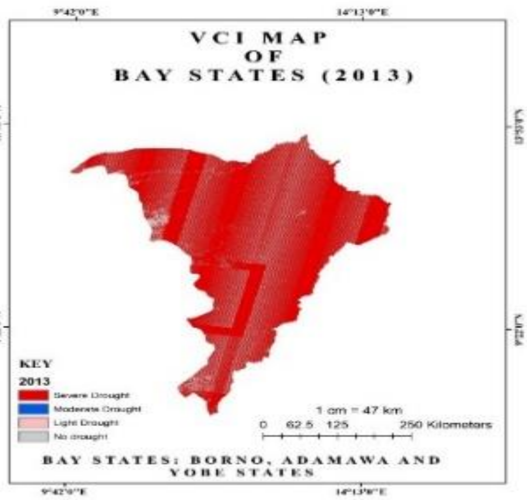
Figure 3. NDDI map of the study area within the last 10 years.

VCI: the VCI of the selected years (2010, 2013, 2018 and 2021) is shown in table 4, the VCI was estimated and found to be between 0 – 100, the VCI map of the study area within the last 10 years is presented in figure 4. Qian, Liang et al. (2016) reported that the VCI ranges from 0 to 100, if the VCI ranges from 70 to 100, it indicates normal vegetation conditions and no drought. A value between 50 and 70 indicates moderate vegetation conditions and mild drought, whereas a value from 30 to 50 indicates poor vegetation growth and moderate drought, and below 30 indicates extremely poor growth conditions and severe drought.

Table 4. VCI effects for the year 2010, 2013, 2018 and 2021

YEARS	Indication	Affected sector
2010	Extreme Drought Condition	Water, Vegetation, and Built up
2013	Extreme Drought Condition	Built Up and Vegetation
2018	Low Drought Condition	Vegetation, and Water bodies
2021	Light Drought Condition	Vegetation and Bare land





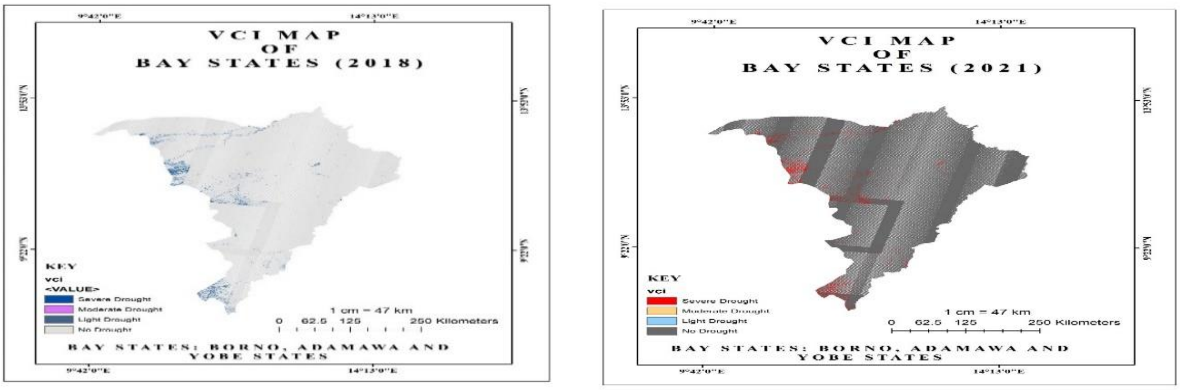
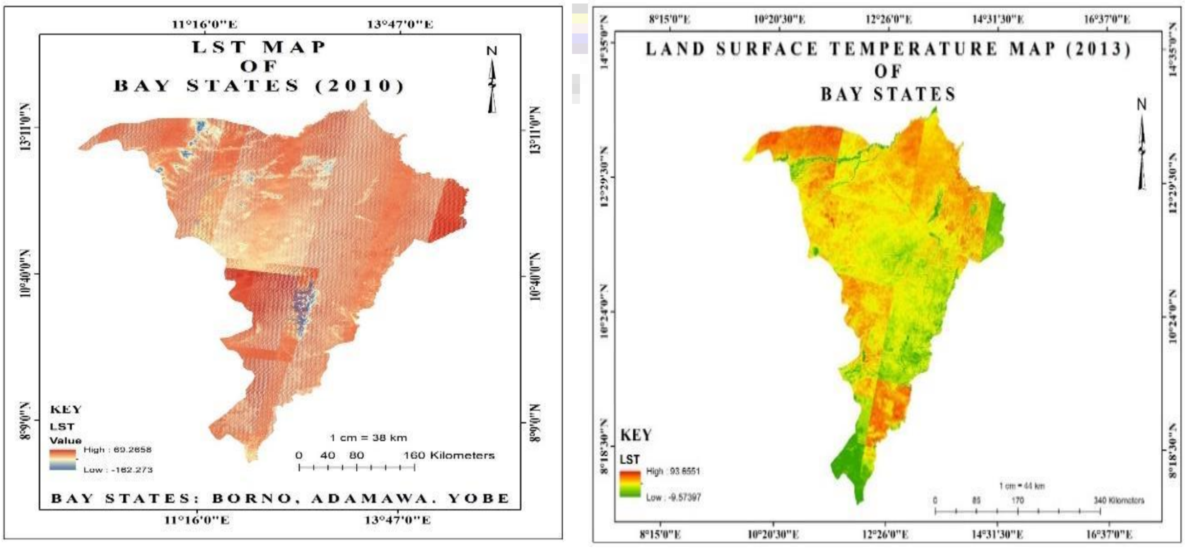


Figure 4. VCI map of the study area within the last 10 years

LST: Table 5 shows the LST results of the study area within an epoch of ten years, and figure 5 shows the LST map of the study area within the last 10 years. Rehman et al. (2002) reported that, the higher the LST value, the high the surface temperature of the area, over 30^0c was shown as the highest temperature value in its research.

Table 5. LST values for the year 2010, 2013, 2018 and 2021

YEARS	LST VALUES	Indication
2010	-162.27 to 69.27	Medium Surface Temperature
2013	-9.57 to 93.66	High Temperature Surface
2018	-3.81 to 93.65	High Temperature Surface
2021	-25.91 to 58.17	Medium Temperature Surface



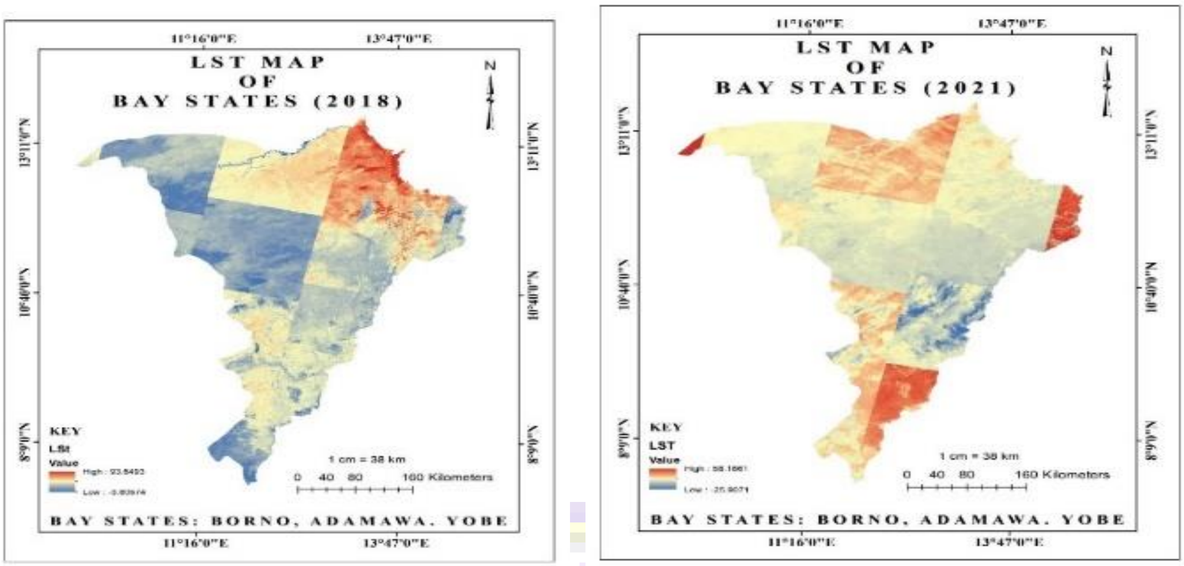


Figure 5. LST map of the study area within the last 10 years

Conclusion

This research was able to adopt the GIS and Remote Sensing techniques in assessing the dynamics and severity of drought in the Borno, Adamawa and Yobe state. In the end, the following were achieved.

The VCI showed that Built Up, Vegetation and Water were massively affected by the drought within the epoch of ten years, while the effect of drought on bare land was lightly effective only in year 2021.

The NDDI showed that Built Up, Vegetation and Water were massively affected by the Drought within the epoch of ten years/.

The LST results showed that the Surface Temperature was medium between 2010 and 2021, while it was severe in 2013 and 2018.

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References

Anderson, J.R. (1971). Spatial Diversification of High-Risk Sheep Farms, in J.B. Dent and J.R. Anderson, eds., system analysis in Agricultural management. 239-266.

Dobri, R.-V., Sfîcˇa L., Amihˇaesei V-A., Apostol L, Tîmpu S. (2021). Drought Extent and Severity on Arable Lands in Romania Derived from Normalized Difference Drought Index (2001–2020). Remote Sens.13, 1478.

Gao, B.C. (1996). NDVI-A normalized difference water index for remote sensing of vegetation liquid water from space. Remote Sens Environ, 58:257–266.

Jaiyeoba, I.A. (2002). Environment in Africa Atlases: Nigeria. 22-123.

Kogan, F. N. (1990). Remote sensing of weather impacts on vegetation in non-homogeneous areas, International Journal of Remote Sensing 11(8), 1405.

Kumar, D., Shekhar S. (2015). Statistical analysis of land surface temperature–vegetation indexes relationship through thermal remote sensing. Ecotoxicol. Environ. Saf. 121, 39–44.

Olagunju, T.E. (2015). Drought, desertification, and the Nigerian environment: A review. Journal of Ecology and the Natural Environmental, 7 (7): 196–209.

Qian, X., Liang, L., Shen, Q., Sun, Q., Zhang, L., Liu, Z., Zhao, S., Qin, Z. (2016). Drought trends based on the VCI and its correlation with climate factors in the agricultural areas of China from 1982 to 2010. Env. Monitoring and assessment 188(11), 1-13.

Rajani, A., S. Varadarajan (2021). Estimation and Validation of Land Surface Temperature by using Remote Sensing & GIS for Chittoor District, Andhra Pradesh.

Rehman, A., Qin, J., Pervez, A., Khan, M.S., Ullah S., Ahmad K. (2002). Land Use/ Land Cover Changes Contribute to Land Surface Temperature: A case study of the Upper Indus Basin Pakistan. Sustainability 14(2), 934.

Renza, D., Martinez, E., Arquero, A., Sanchez, J. (2010). Drought Estimation Maps by Means of Multidate Landsat Fused Images. Remote Sensing for Science, Education, Rainer Reuter (Editor) and Natural and Cultural Heritage, EARSeL.

Rouse, J.W., Haas, R.H., Schell, J.A., Deering, D., Deering, W. (1973). Monitoring vegetation systems in the Great Plains with ERTS Third Symposium, NASA SP-351, pp.309-317

Tsakiris, G., Loukas, A., Pangalou, H., Vangelis, H., Tigkas, D., Rossi, G and Cancelliere, A. (2007). Drought characterization. Chapter 7, Options Mediterraneennes. 58, 85-102.

Van Loon, G. Laaha. (2014). Hydrological drought severity explained by climate and catchment characteristics. Journal of hydrology, volume 19, 3-14.

Yaduvanshi, A, Prashant K.S, Pandey, A.C. (2015). Integrating TRMM and MODIS satellite with socio-economic vulnerability for monitoring drought risk over a tropical region of India. Phys. Chem. Earth, 6. 8-22.