LAPAI
International Journal of Agriculture (LAIJA)

VOLUME 3, ISSUE 1, 2022 ISSN:2705-2869

A Publication of the
Faculty of Agriculture,
Ibrahim Badamasi Babangida University,
Lapai, Niger State, Nigeria

June, 2022

Lapai International Journal of Agriculture (LAIJA)

Lapai International Journal of Agriculture (LAIJA) is a journal of Agriculture managed and published by the Faculty of Agriculture, Ibrahim BadamasiBabangida University, Lapai, Nigeria. LAIJA is a peer reviewed journal that covers all research areas in the field of agriculture: Agricultural Economics and Agribusiness, Animal science and Animal Production, Crop Science and Crop Production, Soil Science and Rehabilitation, Agricultural Entomology, Physiology and Morphology, Aquaculture, Horticulture, Weed Biology, Seed Science research, Stored Products Research, Dairy Science, Pesticide Science, Forestry, Irrigation Research, Climate Change and Agriculture, Population, Food Supply and Food Security, Agricultural Policy and National Development, and Globalization and Agriculture. Its Editorial Board Members are drawn purely from academia in the faculties of agriculture in the universities around the world.

THE EDITORIAL BOARD MEMBERS

Editor-in-Chief
Prof. A. O. Olorunsanya,
Department of Animal Science,
Faculty of Agriculture,
Ibrahim BadamasiBabangida University,
Lapai, Niger State.
+234 (0) 8033791014
tundeolorunsanya@gmail.com

Managing Editor
Prof. Danjuma Solomon
Department of Crop Production,
Faculty of Agriculture,
Ibrahim BadamasiBabangida University,
Lapai, Niger State.
+234 (0) 8131393315
sdanjuma@gmial.comsdanjuma@ibbu.edu.ng

LAIJA Secretary
Mrs. HarunaFati
Directorate of Entrepreneurship
Ibrahim BadamasiBabangida University,
Lapai, Niger State.
+234 (0) 8136033834
Fatimaharuna726@gmail.com

Editorial Board Members
Prof.AbdullahiBala
Department of Crop Production,
School of Agriculture and Agricultural Technology,
Federal University of Technology, Minna.

Prof.AfinikiBawaZarafi
Department of Crop Protection,
Faculty of Agriculture,
Ahmadu Bello University, Zaria

Assist. Prof. Dr. NaritThaochan
Department of Pest Management,
Faculty of Natural Science,
Prince of Songkla University,
Hat Yai, Thailand.

Prof.Akangbe JonesAdebola

Department of Agricultural Economics
and Rural Development,
Landmark University, Omu-Aran

Prof.Bolu, Stephen Abiodun Olaniyi
Department of Animal Production,
Faculty of Agriculture,
University of Ilorin

Prof.AdeoluBabatundeAyanwale
Department of Agricultural Economics,
Faculty of Agriculture,
Obafemi Awolowo University. Ile Ife

Dr. Stanley Dimkpa
Department of Crop / Soil Science
Rivers State Uni. of Science and
Technology,University of Port Harcourt,
Rivers State

Dr. Michael Yao Osae
Radiation Entomology and Pest
Management Centre, Biotechnology and
Nuclear Agriculture Research Institute,
Ghana Atomic Energy Commission,
Ghana

Manuscript Submission

Papers submitted for publication should be typed and double spaced (including abstracts, follow the references and not interspersed (embedded) in the text.

Manuscripts should be exclusively submitted as electronic files (preferably in Microsoft Word) to the Editor-in-Chief at laijaibbul@gmail.com only. Please note that once you have successfully submitted your manuscript, you will receive an email from LAIJA Editorial office thanking you for your submission and provided your submission meet the standard of the LAIJA you shall be requested to pay the sum of N4,000 only as processing fee to the Journal account and the MS reference number will be sent to you not later than 48 hours.

Publication charges

Accepted manuscripts shall be published after the payment of publication fee of must be paid into the journal account in seven days after manuscript have been accepted, otherwise such manuscript shall be dropped. Publication fee should be paid through:

Bank: **UBA Lapai Branch**
Account name: **Lapai International Journal of Agriculture (LAIJA)**
Account Number:**2108963759**

1.Format:

The manuscript should be written in English Language only on A4 paper (2.90 x 2.0cm), Times New Roman, 12 point font size.

2.Cover note:

Manuscripts should be accompanied by a cover note indicating the type of manuscript submitted (original research, short communication, review etc.), it should be stated categorically the aspects of agriculture the manuscript covers as detailed in the aim and scope section. Author should also be allegiant to LAIJA with reference to their submission.

3.Plagiarism:

This is not an acceptable practice. If find the MS will be rejected and author will not be allowed to publish in LAIJA in future. Hence, we advised that all manuscripts should be submitted for plagiarism test (a percentage of 20% will be tolerated) before submission.

Types of Articles

Full length research

This should detail original experiments / research conducted by the authors. Any research on any topic is accepted, provided it falls within the aims and scope of the LAIJA. Original research must add to scientific knowledge on the subject and must be completed in accordance with ethical principles. Research on animals must have applicable ethical approvals.

Short communications

Short communications present new research that adds to previous studies. This can be reporting on the reliability or unreliability of research or informing readers of new factors that may influence the outcome of the study. Authors must acknowledge the work they build upon including any unpublished sources. Manuscripts should not be longer than approximately 1,000 words excluding references.

Reviews

A review is a detailed examination including the benefits and drawbacks of a medicine, therapeutic technique, computer program, policy, or anything else appropriate to the journal. They are substantially composed of a report on previous research. Authors wishing to present original ideas in addition should choose the Commentary type.

Scientific Notes

The Note can be used to announce an important observation or result in a minimal space, of maximum 2 printed journal pages (800 words maximum), which may include one figure or table. The Note should emphasize the method or results with very limited introduction and discussion. For further information, contact the Editors.

INSTRUCTION TO AUTHORS

Authorship

The responsibilities of the senior author when submitting a paper to LAIJA are to ensure that the work has not been previously published, is not under consideration for publication elsewhere and has been approved for submission by all its authors and the institution(s) in which the work was conducted. If the paper is accepted for publication, all authors will transfer copyright of their article to the publisher, after which the publication becomes the property of the journal. It is normally the responsibility of the author(s) to obtain copyright permission to reproduce tables or figures first published elsewhere, and to ensure the correctness of all references. The senior author should also obtain explicit permission (preferably in writing) to use unpublished material cited as a 'personal communication' in the paper.

Manuscript Preparation

Manuscripts (including abstracts) are published in English. Authors are encouraged to translate their manuscripts in other languages into English before submission to LAIJA and to consult an expert in this language if they are not fluent in it.Manuscripts should be prepared according to the following guidelines.

The **title page** should include the article title and the full name(s) and address(es) of all authors, clearly indicating the author to whom correspondence should be addressed. The telephone / mobile number and e-mail contact of the corresponding author should also be provided.

An **abstract** of 250 words or less, to include a brief introduction, statement of the objective of the study, the methodology used and the overall results and conclusions.

Keywords - List 5-7 key subjects covered in the paper and including the scientific names of the major organisms studied, and any important chemical compounds.

Main text - This should be divided into an Introduction, Materials and Methods, Results, Discussion, Conclusion and Acknowledgements.

Data treatment - Means should be reported in the same, or not more than two extra, number of digits as the original individual values. A measure of variability (standard deviation or standard error) should always be presented along with mean values in tabular or graphical forms. When the expression $X \pm A$ is used, always indicate whether A is variance, standard deviation or standard error. It is essential to indicate the sample size or number of replications in tables of means, correlations and other statistical tests results. Whenever the value of a test statistic (e.g. F, T or Chi-square) is presented, the associated degrees of freedom and probability value should be indicated. Appropriate statistical tool for

Danjuma, A. I. L. (2017). Influence of temperature and host plant condition on preimaginal Tropics: Current Status and Future Prospects. John Wiley and Sons, Chichester, New York, Brisbane, Toronto, Singapore. 172 pp. (Include the publisher's name, city of publication and separation of means should be adopted. All measurements must be stated in SI units.

Nomenclature - All organisms should be identified by their Latin names, with taxonomic affiliation and authority indicated at first mention in the abstract and text. Common names should be stated where appropriate. Chemical substances should be described by their generic or common names and defined at least once in the paper by their IUPAC name.

Referencing in text (in chronological order). Throughout the main body of the text, the Harvard (author, date) referencing format must be followed.Examples:Single author (Funso, 2006)Two authors (Gurusu and Egbewande, 2006)Three authors or more (Kumar *et al*., 2006)Multiple authors (Gudugi, 1990; Abdulmaliq and Majin, 1992; Bwala *et al*., 2006).

Reference list (in alphabetical order with full journal titles). Only articles that have been published or are 'in press' should be included. (Note that 'in press' is used only if the paper has been accepted for publication.)Examples:

Journal articles: development and survival in the mango fruitfly, *Bactrocera dorsalis*. Journal of Insect Physiology. 4: 327–335.

In press: Osae, G. A. (2018). Design and construction of the ball trap. Insect Science and Its Application (In press). (The title of the journal/book must be stated in the reference list as well as the expected year of publication).

Books: Isah, A. N., Saxena, K. N. and Gopalan, H. N. B. (Eds) (1995).Weed Management in the page numbers).

Proceedings: Boku, U. (2009). Some quality control parameters used in the rearing of claria fish, pp.

13–29. In Techniques of Fish Rearing for the Development of Economical Management Strategies Vol. 1.Proceedings of an International Group Training on Development of Fish Management Strategies.16 March–3 April 1992, ICIPE, Nairobi, Kenya (Edited by O. O.Egbewande). Animal Science Press, Nigeria. (Include the sponsor of the conference, dates, city and publisher of the proceedings).

Tables, Figure and Pictures – should be constructed appropriately and in editable format. Scanned format are not allowed. All tables, figures and pictures should be numbered accordingly and must have descriptive headings which should be clear and understandable. Titles of tables should be above while that of figures and pictures should be below.

Copyright Submission of a manuscript implies that authors have met the requirements of the editorial policy and publication ethics. Authors retain the copyright of their articles published in the journal. However, authors agree that their articles remain permanently open access under the terms of the

Review Policy The journal operates a blind review policy. Manuscripts are reviewed by editorial board members and or other qualified persons

Editor-in-Chief

Prof. A. O. Olorunsanya
Department of Animal Production,
Faculty of Agriculture,
Ibrahim Badamasi Babangida University, Lapai

Table of Contents

Assessment of Youths' Involvement in Rural-Urban Migration of Niger State, Nigeria

Umaru, A, Idris, N. and Muhammed, Y 619- 631

Influence of Nitrogen rate on Growth and Yield of Two Sweet Pepper (*Capsicum annuun*m L.) Varieties Minjibir, Sudan Savanna of Nigeria

Majin, N. S. , Waziri, A. and Garba, Y. 632- 648

Effects of Different Land Uses on Profile Properties of Alfisols in Southern Guinea Savanna

Abdulmaliq, S. Y., Olaniyan, J. O., Isimikalu, T. O and Majin, N. S 649- 657

Insect Pests Diversity on Cultivated Vegetables at Bakajeba Dry Season Irrigation Site of Lapai-Agaie Dam Niger state, Southern Guinea Savannah

Solomon Danjuma, Abubakar Mohammed Ndako Suleiman Majin and Musa Mahmud Mundi 658-669

Utilization Of Cassava Peel Meal As Substitute For Maize On Growth Indices And Carcass Traits Of Broiler Chickens

Ibrahim. H., and Aliyu, Z. 670-682

Effects Of Butylated Hydroxytoluene On The Quality Of Preserved *Kulikuli,* A Nigerian Snack

James, S., Ndife, J., Yakubu, C. M., Akinsoji, L., Baba, A. I., Audu, Y. and Maxwell, Y. M. O 683-695

Comparative Evaluation Of Different Categories Of Commercial Tisanes (herbal Teas) In Nigeria

James, S., Ndife, J., Yakubu, C. M., Akinsoji, L., Baba, A. I., Audu, Y. & Maxwell, Y. M. O 696-715

Assessment Of Farmers' Socio-economic Characteristics On The Use Of Information Communication Technologies (icts) In Lapai Local Government Area Of Niger State, Nigeria

Ubandoma, G.A., Elejo, J. O, Yakubu, D. H, Haruna, S, Ismail, H. A. 716-731

Evaluation Of Performance Traits And Nutrient Digestibility Of Broiler Chickens Fed Maize Cob As Source Of Fibre At Graded Level

Ibrahim. H, and Aliyu, Z. 732-743

Profitability And Technical Efficiency Of Lowland Rice Farming In Niger State, North Central Nigeria

Lawal, A. F, Bwala, M. A, Gudugi, I. A. S, Paiko, A. M, Sule, B. A, Abdullahi, M. B, Ubandoma, A & Yahaya, G 744-758

Faculty of Agriculture, Ibrahim BadamasiBabangida University, Lapai 2022
Lapai International Journal of Agriculture Vol. 3(1) June,2022 pp 619-631
ISSN:2705-2869

Assessment of Youths' Involvement in Rural-Urban Migration of Niger State, Nigeria

Umaru, A[1], Idris, N[1]. and Muhammed, Y[2].

[1]Department of Agricultural Economics and Extension Services,
Ibrahim Badamasi Babangida University, Lapai
[2]Department of Agricultural Extension and Rural Development,
Federal University of Technology, Minna, Niger State

Correspondent's Email: umaru3959@gmail.com Phone: +2348030733154; +2348124526212

ABSTRACT

The study assessed youths' involvement in rural-urban migration in Niger State, Nigeria. Three-stage sampling procedure was used to select 120 respondents on which structured questionnaire were administered complimented with an interview schedule to collect primary data subjected to descriptive statistics. The results obtained revealed that majority (73.3%) of the respondents were within the age brackets of 41-60 years, 95.8% of the respondents were male, 98.3% were married and 76.6% had no formal education. More so, more than half (51.7%) of the respondents had farming experience of greater than 25 years, while majority (75.0%) had farm size of less than 2 hectares. The socio-economic groups of youth that migrate across gender and age revealed that majority (91.7%) of the migrants were able-body male youths which usually lead to reduction in agricultural output in the study area. Also, most (66.7%) of the youths that migrate were within the age brackets of 21-40 years. However, nature of migration in the study area as indicated by majority (89.2%) of the respondents is temporary, while the perceived factors influencing migration were advancement of educational level (49.2%), absence of industries in rural area (40.0%), attracting news of city life (38.3%) and inadequate social amenities (32.5%) ranked 1st, 2nd, 3rd and 4th, respectively. The study concluded that youths are highly involved in rural-urban migration particularly male youths. It was therefore recommended that Government and Non-Governmental Organizations (NGOs) should established functional social infrastructures and industries particularly agro-allied industries that will provide job opportunities to youths in the study area.

Keywords: Assessment, youths' involvement, rural-urban migration, respondents.

INTRODUCTION

Migration is the movement of people from one geographical location to another either on a temporary or permanent basis. It has been observed all over the world, that the common pattern in internal migration is from rural to urban areas (Ekong, 2010). According to Mini (2011), rural-urban migration has effect on rural economy leading to chronic poverty and food insecurity. These are mainly due to excessive movement of youth from the rural populace to urban area leaving only the aged members to constitute the labour force of agricultural production. In Nigeria, it has been found that the lack of an opportunity to earn cash income during the slack season in the farming calendar and sometimes rural-rural wages differential have cause (Ekong, 2010; Babatunde *et al.,* 2013). In addition, to economic motive, people migrate to improve their education and skills in rural areas with poor educational facilities and want to acquire education have to move out. Also, people with higher education in rural areas tend to migrate in order to find commensurate employments in the cities, escape from social and cultural imprisonment in homogenous rural areas (Ekong, 2010; Babatunde *et al.,* 2013).

According to Smith and Zopes (2003), lack of basic amenities, ready wage from urban work, prospect of enjoying urban facilities, expulsion due to offence or social crime or escape from social stigma, and presence of relatives and friends in areas of destination might equally be related to increase out-migration. People tend to be pulled to areas of prosperity and pushed away from areas of decline. The greater difference in economic opportunities between urban and rural areas tends to increase influx of migrants from rural to urban centres (Makinwa, 2004). John (2003) stressed that rural-urban migration has led to demand for urban socio-economic amenities exceeding their supply, the urban areas often become spectacles of multifarious problems such as overcrowding, congestion, inadequate housing, high rate of unemployment and underemployment, crime and other forms of delinquency. It has also negatively impacted on the agricultural sector leading to decrease labour force and agricultural output.

Rural-urban migration has over the years created labour shortages in agricultural production due to migration of able-body youths to cities in search of white-collar jobs leading to decrease agricultural output (Afolabi, 2007). It is also a clear fact that most crops grown in Northern parts of Nigeria takes less than six months to mature for harvest, giving young farmers opportunities to migrate to other parts of the country to look for other sources of livelihood before the onset of the next raining season. It is against this backdrop that the study was carried out to assess youths' involvement in rural-urban migration in the study area. The specific objectives of the study are to: describe the socio-economic characteristics of the farming households, examine the socio-

economic groups of youth that migrate across gender and age, nature of rural-urban migration and assess the perceived factors influencing youths' rural-urban migration in the study area.

METHODOLOGY

Study Area

The study was carried out in Niger State, Nigeria located on Latitude 3^0 20′ North and Longitude 11^0 30′ East of the Greenwich Meridian. It covers an estimated land mass of 13,653 square kilometer with about 85% arable land. Niger State is divided into three Agricultural Zones with each of these zones has their headquarters at Bida, Kuta and Kontagora, respectively. The population of the State is 3,955,072 million consisting of 2,004,350 males and 1,950,722 females (National Population Census (NPC), 2006). However, the projected population as at 2019 using 3.2% growth rate was 6,139,477 with male population of 3,159,261 and female population of 2,980,216 (Niger State Agricultural Mechanization and Development Authority (NAMDA), 2019). The dominant tribes are Nupe, Gwari, and Hausa, while other minority tribes like Fulani, Kanbari, Kakanda Dibbo, Kamuku, Ganagana, Ibo and Yoruba were present. The State falls in the Guinea Savannah ecological zone of Nigeria with mean annual rainfall of 1,100mm in the Northern and 1,400mm in the Southern axis of the State, while mean temperature is usually not exceeding 44^o C during the dry season. Niger State is home to four (4) Hydro-Electric Power Station with a lot of tourist attractions, while the major economic activity is agriculture (farming, fishing and livestock rearing).

Sampling Procedure and Sample Size

The population for the study comprises of rural farming households in Niger State, Nigeria. Three-stage sampling procedure were used to select respondents for the study. The first stage was random selection of two (2) Local Government Areas from each of the three Agricultural Zones (Zone I, II and III) of the State (Gbako and Lapai in Agricultural Zone I, Bosso and Paikoro in Agricultural Zone II, and Bangi and Wushishi in Agricultural Zone III). In the second stage, two (2) villages was randomly selected from each of the LGAs to obtained 12 villages. In the third stage, snowball approach was used to select 10 respondents from each of the villages to get a total of 120 respondents.

Data collection and Analysis

Primary data was used for the study which was collected through structured questionnaire complimented with an interview schedule. Content validity of the instrument for data collection was ensured through experts' consultation. Data collected were analyzed using descriptive statistics such as frequency count and percentage.

RESULT

Socio-economic characteristics of the respondents

The results in Table 1 revealed that majority (73.3%) of the sampled respondents fall within the age brackets of between 41-60 years implying that it is basically the aged people that are left to work on the farm as a result of the migration to cities by the youth who have the physical power to work on the farm. Majority (95.8%) of the respondents were male, while 4.2% were female. Also, majority (98.3%) of the respondents were married, while 1.7% were single. More so, majority (76.6%) of the respondents had non-formal education, while 23.4% had one form of formal education or the other.

Table 1: Distribution of respondents based on their socio-economic characteristics (n=120)

Variables	Frequency	Percentage (%)
Age (years)		
21 – 40	100	66.7
41 – 60	47	31.3
Above 60	3	2.0
Marital status		
Single	3	2.0
Married	122	81.3
Divorced	5	3.3
Separated	2	1.3
Widow	18	12.0
Educational Level		
Quranic	86	57.3
Primary	27	18.0
Secondary	10	6.7
Non-formal	23	15.3
Adult	4	2.7
Major Occupation		
Farming	114	76.0
Trading	12	8.0
Civil servant	1	0.7
Artisan	23	15.3
Farm Size (ha)		
0.5 – 1	103	68.7
1.5 – 2	45	30.0
2.5 – 3	2	1.3
Farming Experience (years)		
1 – 10	120	80.0
11 – 20	27	18.0
21 – 30	3	2.0

Source: Field Survey, 2019

Furthermore, Table 1 revealed that more than half (51.7%) of the respondents had farming experience of greater than 25 years. Majority (75.0%) of the farmers had farm size of less than 2 hectares implying that they are mostly small-scale farmers, while 86.7% of the respondents acquired their farmland on which they carry out farming activities through inheritance implying that majority of the farmers do not pay for farmland for agricultural production. Also, majority (91.7%) of the respondents were full time farmers, while 8.3% of them were into other occupation such as trading and civil service.

Socio-economic groups of youth that migrate across gender and age

As revealed in Table 2, majority (91.7%) of the youth migrants were male, while 8.3% were female. This may not be far from the fact that men move more freely in the Northern part of the country in search of better living condition when compared to women.

Table 2: Distribution of youth migrants based on gender

Variables	Frequency	Percentage (%)
Male	110	91.7
Female	10	8.3
Total	**120**	**100.0**

Source: Field Survey, 2013

More so, Table 3 revealed that majority (79.2%) of migrants were in their youthful age brackets of within 21 – 40 years implying that at this age bracket there is the tendency to move from one location to another in search of greener pasture.

Table 3: Distribution of youth migrants based on age (years)

Variables	Frequency	Percentage (%)
< 21	12	10.0
21 – 30	33	27.5
31 – 40	47	39.2
41 – 50	22	18.3
> 50	6	5.0
Total	**120**	**100.0**

Source: Field Survey, 2013

Nature of youths' migration

Results on nature of youths migration experienced in the study area presented in Table 4 revealed that majority (89.2%) of the migrants do migrate on temporary basis, while only 10.8% of the migrants do migrate permanently. This implies that most of the migrants do not stay permanently at their destination except few.

Table 4: Distribution of respondents based on nature of migration

Variables	Frequency	Percentage (%)
Permanent	13	10.8
Temporary	107	89.2
Total	**120**	**100.0**

Source: Field Survey, 2013

Perceived factors influencing youths' rural-urban migration

Table 5 revealed that the need to acquire advance education (49.2%) ranked 1st among the perceived factors influencing migration thus the most important reason for which young people migrate to urban centres. This was followed by absence of industries (40.0%), attracting news of city life (38.3%) and inadequate social amenities ranked 2nd, 3rd and 4th, respectively.

Table 5: Factors influencing rural-urban migration by the respondents

Variables	Frequency*	Percentage (%)	Ranking
Advancement of educational level	59	49.2	1st
Absence of industries	48	40.0	2nd
Attracting news of city life	46	38.3	3rd
Inadequate social amenities	39	32.5	4th
Joining one's relative in town	11	9.2	5th
To avoid boredom in agriculture	8	6.7	6th
Apprenticeship in various vocation	4	3.3	7th
Expulsion due to office/crime	3	2.5	8th
Health reason	2	1.7	9th

Source: Field Survey, 2013

***Multiple responses allowed**

DISCUSSIONS

Socio-economic characteristics of the respondents

The results in Table 1 revealed that majority (73.3%) of the sampled respondents fall within the age brackets of between 41-60 years. This is a clear indication that it is basically the aged people that are left to work on the farm as a result of the migration to cities by the youth who have the physical power to work on the farm. This result is in line with the findings by Ekanone (2004) who reported that decline in crop production is because most farmers are old with low productivity. Also, majority (95.8%) of the respondents were male, while 4.2% were female. This result implies male dominance of agricultural activities which could be unconnected with the cultural and religious beliefs in the in the study area. This result agrees with the finding of Alscher (2011) who reported that men have comparatively greater opportunity than women in farming activity due to special constraints that women face.

As revealed in Table 1, majority (98.3%) of the respondents were married, while 1.7% were single. This result implies that the respondents were highly responsible thus the need to cater for the children. This could make members of the family especially male youths to move to cities in search of jobs during the off-season. This result is in line with the finding of John (2003) who reported that young people move to cities for other source of livelihood during off-season. More so, majority (76.6%) of the respondents had non-formal education, while 23.4% had one form of formal education or the other. The lack of formal education in the rural areas could have forced many youths to migrate to town to acquire formal. This result agrees with the finding by Smith and Zopes (2003) who reported that growth in demand for education is among youths is a factor contributing to rural-urban migration because educational facilities in the urban areas.

Furthermore, Table 1 revealed that more than half (51.7%) of the respondents had farming experience of greater than 25 years. This implies that the respondents possess enough experience to carry out farming activities in the study area. This finding in line with Amos (2007) who reported that farming experience is important for day to day running of the farming activities. Majority (75.0%) of the farmers had farm size of less than 2 hectares implying that they are mostly small-scale farmers, while 86.7% of the respondents acquired their farmland on which they carry out farming activities through inheritance implying that majority of the farmers do not pay farmland for agricultural production. However, the small farm size could be as a result of the fact that most of the farmers acquired their farmland through inheritance usually associated with fragmentation thereby discouraging large scale production. Majority (91.7%) of the

respondents were full time farmers, while 8.3% of them were into other occupation such as trading and civil service.

Socio-economic groups of youth that migrate across gender and age

As revealed in Table 2, majority (91.7%) of the youth migrants were male, while 8.3% were female. This implies that there were more male migrants than female in the study area. This may not be far from the fact that men move more freely in the Northern part of the country in search of better living condition when compared to women. This could be attributed to Islam being the major form of religious in the study area. This finding is in line with Ejiogun (2009) who reported that young males were more involved in migration than female in Northern Nigeria.

More so, Table 3 revealed that majority (79.2%) of migrants were in their youthful age brackets of within 21 – 40 years. This implies that at this age bracket there is the tendency to move from one location to another in search of greener pasture. This agrees with findings of Fadayomi (1994) who reported that young people show more interest to migrate from rural to urban centres as compared to aged or old individuals. The author further stressed that; this has a serious implication for rural labour supply as it tends to drain the sector of people in the most active age with negative consequence on agricultural output and productivity.

Nature of youths' migration

Results on nature of youths migration experienced in the study area is presented in Table 4 and it revealed that majority (89.2%) of the migrants do migrate on temporary basis, while only 10.8% of the migrants do migrate permanently. This implies that most of the migrants do not stay permanently at their destination except few. This suggests that most of the migrants maintain two homes (place of origin and destination area), thus returns home to spend holidays, attend and celebrate major religious, social and cultural festivals. The implication of this finding is that, temporary migrants owned their loyalty in terms of contribution to their village or town of origin than the destination community. However, the decision of some migrants who choose not to return to their communities are the type of migrants that usually causes decline in agricultural productivity, because the people involved in this movement have chosen to settle permanently in the urban area for greener pasture. This category of migrants usually involves younger and able-bodied individual who are capable of performing active roles in agricultural production. This finding however contradicts that of Fasoranti (2009) who reported that up to two-third of those involved in migration often do not return to their communities.

Perceived factors influencing youths' rural-urban migration

Table 5 revealed that the need to acquire

advance education (49.2%) ranked 1st among the perceived factors influencing migration thus the most important reason for which young people migrate to urban centres. This was followed by absence of industries (40.0%), attracting news of city life (38.3%) and inadequate social amenities ranked 2nd, 3rd and 4th, respectively. This result implies that young people who are desirous of acquiring higher education do migrate to city where the educational facilities are available. Also, youths with skills or higher education in rural areas prefers to migrate to find commensurate employment in the cities. The implication of this finding is that as the able–body youths migrate to city to see more of the world beyond their villages, the village farm labour force tends to suffer leading to decrease agricultural output and productivity. This finding agrees with that of Makinwa (2004) and Fasoranti (2009) who reported that many able-body young people with reasonable level of education prefer to migrate to township in search of greener pasture rather than stay in rural area.

CONCLUSION

In conclusion, the result of this study revealed that most of the people involved in rural-urban migration were youths. The rate of rural-urban migration among youth is very high and poses a challenge to agricultural sector of the State and Nation as a whole. Most of the migrants were able-body male youths who form the bulk of the agricultural labour force, leaving behind aged people, women and young siblings. These usually resulted into loss of the productive members of the rural community and consequently decline in agricultural production, low output, less income and diversification to non-agricultural business.

Recommendations

Based on the findings of the study, the following recommendations were proffered:

i. To prevent youths rural-urban migration; Government and relevant stakeholders should provide social amenities and infrastructures in rural areas such as schools, electricity, pipe-borne water, hospitals and recreation centre.

ii. Non-Governmental Organizations and Financial Institutions should set up industries particularly agro-allied industries to provide job opportunity in the rural areas in order to reduce rural-urban migration.

iii. Higher educational institutions should equally be established by Government and relevant stakeholders in rural areas to pave way for rural youths to acquire higher knowledge and skills that will lead to increase agricultural production.

iv. Also, financial institutions should enhance access to credit facilities by rural farmers including women headed households who have lost significant youth migrants to cities to acquire agricultural inputs and farming technologies to improve

level of production. This could help to attract the youths back to the rural areas.

REFERENCES

Afolabi, M. O. (2007). Rural – Urban Migration and Production in Nigeria Agricultural Sector. Unpublished Ms.C Thesis Submitted to Simon Fraser University, Burnaby, B.C., Canada.

Alscher, S. (2011). Environmental degradation and migration on Hispaniola Island. *International journal of Migration,* 49 (1), 164 – 188.

Amos, T. T. (2007). An Analysis of Productivity and Technical Efficiency Smallholder Cocoa Farmers in Nigeria. *Journal of Social Science,* 15 (2), 127 – 133.

Ejiogun, A. O. (2009). Gender analysis of rural-urban migration in Imo State, Nigeria Paper presented at the Oxford Business and Economics Conference, Oxford England. St. Hugh's College, Oxford University, June 24-26, 2009

Ekong, E. E. (2010). *Rural Sociology: An introduction and Analysis of Rural Nigeria (3rd Edition).* Uyo, Dove Educational Publishers, Pp 279 – 282.

Fadayomi, T. O. (1994). Rural Development and Migrationin Nigeria: impact on the Eastern Zone of Bauchi State Agricultural Development Project. Nigeria Institute of Social and Agricultural Research, Ibadan, Nigeria

Fasoranti, O. O. (2009). Perception of rural-urban migration of selected rural communities inOndo State, Nigeria.*Bangladesh e-journal of Sociology,* 6 (1), 96-105.

John, R. O. (2003). *Population: An Introduction to Concept and Issue (3rd Edition).* Belmont, California: Wadsworth Publishing Company, Pp 174.

Makinwa, P. K. (2004). *International Migration and Rural Development In Nigeria Lesson from Bendel State*. Heinemann Educational Book Publishers Nigeria Limited, Pp 16.

Mini, S. E. (2011). "The Impact of Rural-Urban Migration on Rural Economy in Rural Villages". Retrieved October 12, 2013 http://www.Onlinenigeria.com/links/agricadv.asp.

National Population Commission (NPC) (2006). Provisional Census Figure of Nigeria: NPC/FGN, Abuja, Nigeria.

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

Smith, T. I. & Zopes, P. E. (2003). *Principles of Inductive Rural Sociology*. England: Davies Company Limited, pp 116 – 118.

Faculty of Agriculture, Ibrahim BadamasiBabangida University, Lapai 2022
Lapai International Journal of Agriculture Vol. 3(1) June,2022 pp 632-648
ISSN:2705-2869

Influence of Nitrogen rate on Growth and Yield of Two Sweet Pepper (*Capsicum annuum*m L.) Varieties Minjibir, Sudan Savanna of Nigeria

Majin, N. S. , Waziri, A. and Garba, Y.

Department of Crop Production, Ibrahim Badamasi Babangida University, Lapai, Niger State, Nigeria

Corresponding author email—ndakosma07@yahoo.com

ABSTRACT

Field experiment was carried out at the research farm of Institute for Agricultural Research (I.A.R.), Ahmadu Bello University, Minjibir, Kano substation (12^0 18' N and 08^0 66' E; 968m above sea level) in Sudan Savanna of Nigeria, in 2012 and 2013 rainy seasons to investigate influence of nitrogen rates (0, 70, 140 and 210 kg N ha^{-1}) in form of urea on growth and yield of two sweet pepper (*Capsicum annuum* L.) varieties (California Wonder and Yolo Wonder). The treatments were laid out in randomized complete block design (RCBD) replicated three times. Observations made on growth characters were plant height, shoot dry weight per plant, leaf area index (LAI) at 4, 6, 8 and 10 weeks after transplanting (WAT) and net assimilation rate (NAR) per plant at 4-6, 6-8 and 8-10 WAT. The yield and yield components studied included fruit length, fruit width, number of fruits per plant and total fresh fruit yield ha^{-1}. Applications of nitrogen fertilizer up to 210 kg ha^{-1} significantly influenced growth parameters of sweet pepper varieties studied at Minjibir especially plant height and shoot dry weight but 70kg N ha^{-1} gave significantly higher number of fruits per plant and fresh fruit yield ha^{-1}. Yolo Wonder variety had statistically higher values for growth characters of the sweet peppers, while the California Wonder variety outperformed in terms of yield and yield components in both seasons. The results obtained from this trial revealed that nitrogen at 70kg ha^{-1} gave the greatest fresh fruit yield of 8.44 tons ha^{-1} while up to 210kg N ha^{-1} stimulated more crop growth in the varieties. The California Wonder variety produced higher fresh fruits of 8.04 tons ha^{-1} than Yolo Wonder in the Sudan savanna of Nigeria. It is therefore recommended to farmers in Minjibir Kano to cultivate California Wonder variety of sweet pepper with application of 70 kg N ha^{-1} to obtain greater fresh fruit yield.

Keywords: Nitrogen, Sweet pepper,Yield, Growth, Sudan Savvana

Faculty of Agriculture, Ibrahim BadamasiBabangida University, Lapai 2022
Lapai International Journal of Agriculture Vol. 3(1) June,2022 pp 632-648
ISSN:2705-2869

INTRODUCTION

Capsicum annuum L., commonly known as sweet pepper, originated from Central America where it formed part of the diet of ancient people there, since 7,500 BC. Native Americans had domesticated and cultivated peppers between 5,200 and 3,400 BC. Some wild species of peppers were found in Central and South America from which the various types known today were developed (Crosby, 2008; Nadeem *et al.,* 2011; Grundberg, 2014). Christopher Columbus who discovered America in the 15th century carried pepper plants and seeds to Europe from where they were spread around the world through colonial trade networks (Grundberg, 2014). They were introduced to Africa and India by Portuguese traders along with tomato, papaya, pineapple, amongst others, by the end of 17th century (Lawal and Fagge, 2011; Reddy, 2012; Grundberg, 2014).

Peppers *(Capsicum sp)* are members of the Family *Solanaceae* that include potatoes, tomatoes, nightshade plants. They are mainly cultivated in warm tropical and subtropical parts of the world where temperatures range from 20 - 30^{0}C. Sweet peppers are the most important and widely cultivated peppers in the world (Rice *et al*., 1987; Udo *et al.,* 2004; Anonymous, 2014a). Their useful berry fruits are nutritious and are served fresh with salad or cooked with other vegetables, fish and meat as soup or stew. They are used for stuffing and can be roasted, grilled or stir-fried. They are good sources of vitamins A; B_1; B_2; C and E together with some essential nutrient elements like calcium (Ca); potassium (K); phosphorus (P), nitrogen (N) and iron (Fe) (Amans, 2011; Shafeek *et al.,* 2012 and Anonymous, 2015). The fruits can be preserved by canning, drying or freezing (Malik *et al.,* 2011; Anonymous, 2012a; Aminifard *et al.,* 2013).

Sweet pepper plants are also commonly used as ornamental plants because of their beautiful glossy fruits of many colors – green, yellow, red, orange, black, purple and brown. Industrially the pigments from ripe fruits are used as natural coloring agents for food products and cosmetics (Aliyu, 2000; Acquaah, 2004; Anonymous, 2012a). Oleoresin extracted from the fruits impacts characteristic flavor to some food products (Singh and Naik, 1990; Shafeek *et al.,* 2012; Hoven, 2013). Green pepper fruits also contain phenolic acids and carotenes e.g. zeaxanthin, lycopene, lutein, alpha-carotene and beta-carotene that are antioxidants, anti-inflammations and for protection against cardiovascular disorders, cancers and eye diseases (Amans, 2011; Lawal and Fagge, 2011; Nadeem *et al.,* 2011; Aminifard *et al*., 2013).

Sweet pepper is an important export commodity globally and in many African countries. Nigeria for example was a major African producer and exporter of peppers in the 1950s and 1960s. Amadala (2016) reported that global pepper production in 2015 was up to 34.6 million metric tons (MT) of fresh fruits. China the largest world producer accounted for some 17.65 million

MT (51%) while USDA (2011) found Nigeria a major African producer with only 723,000 metric tons.

Nitrogen is one of the most important macronutrient elements required for normal healthy growth and development of many plants because it is used to make proteins, nucleic acids, chlorophylls, cytochromes, enzymes, vitamins, alkaloids, etc. in their bodies for healthy development and heredity (Havlin *et al.* 2006). Jones and Wild (1975) stated that the savanna soils of Nigeria are inherently low in available nitrogen for crops. This has made application of correct levels of nitrogen to these soils very important for high yields from crops grown in these regions. Many researchers have reported improvement in crop yields in Nigeria savannas as a result of increased level of nitrogen fertilizer application to these soils (Abdulmaliq, *et al*., 2014). Olaniyi and Ojetayo (2010) stated that the positive response and increase in growth and yield of peppers with applied fertilizer might be due to the low initial nutrient status of the used soils.

Grundberg (2014) reported that many high yielding and disease resistant sweet pepper types developed in advanced countries e.g. USA, Britain, Germany etc such as California Wonder, Yolo Wonder, Aladdin, Red Knight, Marconi and Socrates need to be introduced to our farmers for sustainable higher fruit yields. Some of these varieties can divert most of the energy and materials in their bodies into fruits and seed productions during dry matter partitioning in the crops (Jain, 2009).

MATERIALS AND METHODS

The experiment was performed at Institute for Agricultural Research (IAR) research farms, Ahmadu Bello University (ABU) substation Minjibir, Kano ($12^0$18' N and 08^0 66' E; 968m above sea level) in Sudan Savanna, Nigeria in 2012 and 2013 rainy seasons. Soil samples of the experimental sites were taken at random from various parts of the trial fields from 0 - 30 cm depths and analyzed to determine the physical and chemical characteristics using standard methods (Black, 1965). The result is shown in Table 1.

Treatments were of factorial combinations of nitrogen at 0, 70, 140 and 210 kg N ha^{-1} with Urea (46%) and two sweet pepper varieties namely California Wonder and Yolo Wonder. These were laid out in randomized complete block design (RCBD) replicated three times. Seeds of the two varieties dressed with Apron Star (20% w/w metalaxyl-M; 20% w/w thiamethoxam and 2% w/w difenoconazole) against soil born pests and diseases were sown on separate nursery beds for each variety in shallow drills 10cm apart and lightly covered with soil. They were mulched with dry grasses straws after sowing and watered with watering can. The mulch was removed when the seedlings emerged and were cared for five weeks before transplant on to trial sites.

All agronomic practices for optimum performance of the crops were carried out

on the fields when necessary. Five pepper plants were tagged randomly with small water proof cardboards in each net plot. Biometric observations on growth characters such as plant height, dry weight per plant, leaf area index (LAI) per plant were recorded at 4, 6, 8 and 10 weeks after transplanting (WAT) and net assimilation rate (NAR) per plant was done at 4 – 6, 6 – 8 and 8 – 10 WAT. The means of observations from these tagged plants per plot for each sampling period were calculated. Yield and yield components studied included fruit length, fruit width, number of fruits per plant and fresh fruit yield ha^{-1}. Five fruits were randomly picked from those harvested for each net plot and their fruit lengths and width were measured with Vanier caliper. The number of fruits on the net plot was counted and the mean evaluated per plant. Fruits harvested were weighed for each net plot using the Mettler-P1210 electronic balance and fresh fruit yields extrapolated to tons ha^{-1}.

All the data collected from the observations were subjected to the statistical analysis of variance (ANOVA) as described by Steel and Torrie (1984). The differences between treatment means were separated using Duncan's Multiple Range Test (DMRT) at 5% level of significance (Gomez and Gomez, 1984).

RESULTS

Analysis of soils of research locations and weather data

The results of physical and chemical characteristics of soils of the research sites in 2012 and 2013 at Minjibir in Sudan savanna of Nigeria are presented in Table 1. The soil textural classes in both years were of loamy sand soils. Soils *pHs* in both years were slightly acidic and they were low in organic carbon, total nitrogen and available phosphorus contents. The nutrient contents and most exchangeable bases for example Ca^{2+}, Mg^{2+} and K^{+} of the soils were low at Minjibir in the years. The moderate rainfall regime of 700 - 800mm (MAR) and warm temperatures of about 30^{0}C with relative humidity of 60 to 70% that occurred in 2013 at Minjibir appeared more favorable for the tested sweet pepper varieties since their productivities were better in 2013 than in 2012.

Effects of nitrogen rates on growth parameters of sweet pepper varieties

Nitrogen rates were found to affect all the growth parameters of sweet pepper varieties studied in this research. Each increase in heights of the sweet pepper varieties correspond to increase in applied N rate at Minjibir during 2012 and 2013 rainy seasons from the results shown in Table 2. Plant heights increased with each increase in N rate from 0 up to 210kg ha^{-1} at 4 WAT in both seasons and in 2013 at 6 WAT. At all other sampling periods, crops supplied with 140 and 210 kg N ha^{-1} had statistically similar heights which were statistically taller than those supplied with lower N rates and of the control.

Consistently the Yolo Wonder plants were

significantly taller than the California Wonder in the two years of the research, at 4, 6, 8 and 10 WAT in Minjibir. There was no significant interaction of the treatments on plant height.

Table 1; Physical and chemical properties of the soils of experimental sites at Minjibir in Sudan savanna during 2012 and 2013 rain seasons.

Soil Properties		
	2012	2013
Physical Properties (g kg $^{-1}$)		
Sand	816	798
Silt	074	079
Clay	110	123
Soil texture	Loamy sand	Loamy sand
Chemical Properties		
pH (H_2O)	5.30	6.00
pH (0.01M $CaCl_2$)	4.60	4.90
Organic carbon (g kg^{-1})	3.50	3.80
Available phosphorus (mg kg^{-1})	8.72	6.95
Total Nitrogen (g kg^{-1})	2.90	3.20
Exchangeable bases (c mol kg^{-1})		
Calcium (Ca^{2+})	1.32	1.09
Magnesium (Mg^{2+})	0.87	1.16
Potassium (K^{+})	0.15	0.21
Sodium (Na^{+})	0.24	0.22
Exchangeable acidity (Al + H)	0.13	0.14
Cation Exchange Capacity (CEC)	2.51	2.80

Table 2; Plant heights (cm) of sweet pepper varieties as affected by nitrogen rate at different sampling periods in 2012 and 2013 rainy seasons at Minjibir.

Treatments	Plant heights							
	4 WAT		6 WAT		8 WAT		10 WAT	
	2012	2013	2012	2013	2012	2013	2012	2013
Nitrogen rate (kg ha^{-1})								
0	11.40d	11.57d	17.12c	18.41d	27.34c	29.50c	33.39c	34.25c
70	12.47c	12.74c	19.27b	21.21c	33.73b	35.44b	42.75b	43.36b
140	13.19b	13.36b	20.35a	22.06b	35.83ab	37.84a	46.68a	47.01a
210	14.28a	14.38a	21.27a	22.81a	37.01a	39.17a	46.41a	47.59a
SE±	0.204	0.191	0.328	0.217	0.793	0.518	0.886	0.567
Varieties								
California Wonder	12.28b	12.50b	17.68b	18.81b	30.38b	32.17b	39.32b	39.91b
Yolo Wonder	13.39a	13.53a	21.32a	23.43a	36.58a	38.80a	45.30a	46.20a
SE±	0.229	0.135	0.232	0.153	0.567	0.366	0.627	0.401
Interactions								
N x V	NS	NS	NS	NS	NS	NS	NS	NS

Means followed by same letter in a column and treatment group are not statistically different at 5% level of probability using DMRT. NS = Not significant; * = Significant, N = nitrogen, V = variety

Table 3 contains crop shoot dry weights of the sweet pepper varieties as affected by nitrogen fertilization in 2012 and 2013 rainy seasons at Minjibir. Each increase in N rate applied to the peppers from 0 to 210 kg ha^{-1} led to significant increase in dry weights per plant except in 2012 at 4 and 6 WAT when crops supplied 140 and 210 kg N ha^{-1} had statistically similar shoot dry weights per plant. Yolo Wonder variety gave higher dry weights per plant than California Wonder at all the sampling periods in the seasons. No interaction was significant.

The results in Table 4 reveal the effects of rates of N on leaf area index (LAI) per sweet pepper plant at various sampling periods in 2012 and 2013 at Minjibir. Increasing N rates from 0 to 210 kg ha^{-1} significantly increased LAI per plant of these pepper varieties in each of the years. The difference in LAI between the two varieties was significant. Yolo Wonder variety consistently gave significantly higher LAI per plant than the California Wonder.

Influence of rates of nitrogen on net assimilation rate (NAR) per sweet pepper plants at some sampling periods in 2012 and 2013 at Minjibir are presented on Table 5. The NAR per pepper plant was observed to increase with each increase in N rates up to 210 kg ha^{-1} at most sampling periods in the seasons except at 8 – 10 WAT in 2013 when plants supplied with 70 and 140 kg N ha^{-1} produced statistically similar NAR. California Wonder variety consistently gave statistically lower NAR per plant than the Yolo Wonder in the seasons and times of sampling.

Table 3; Shoot dry weights (g) per plant of sweet pepper varieties as affected by nitrogen rate at different sampling periods in 2012 and 2013 rain seasons at Minjibir.

Treatments	Shoot dry weights / plant							
	4 WAT		6 WAT		8 WAT		10 WAT	
	2012	2013	2012	2013	2012	2013	2012	2013
Nitrogen rate (kg ha^{-1})								
0	8.63b	9.07d	16.01c	16.82d	30.95d	33.74d	66.29d	72.96d
70	10.26b	11.10c	21.34b	23.64c	47.34c	48.36c	113.01c	117.10c
140	12.27a	12.54b	24.71a	25.94b	54.09b	57.52b	125.46b	134.69b
210	13.31a	13.44a	26.16a	28.58a	57.53a	61.99a	140.56a	146.12a
SE±	0.465	0.277	0.761	0.432	1.200	0.763	1.873	1.546
Varieties								
California Wonder	10.34b	10.68b	20.64b	22.10b	46.02b	48.34b	107.18b	114.66b
Yolo Wonder	11.90a	12.20a	23.47a	25.39a	48.94a	52.46a	115.48a	120.78a
SE±	0.329	0.225	0.609	0.467	0.848	0.554	1.324	1.528
Interaction								
N x V	NS	NS	NS	NS	NS	NS	NS	NS

Means followed by same letter in a column and treatment group are not statistically different at 5% level of probability using DMRT. NS = Not significant; * = Significant, N = nitrogen, V = variety.

Table 4; Leaf area index (LAI) per plant of sweet pepper varieties as affected by nitrogen rate at different sampling periods in 2012 and 2013 rain seasons at Minjibir.

Treatments	Leaf area index / plant							
	4WAT		6WAT		8WAT		10WAT	
	2012	2013	2012	2013	2012	2013	2012	2013
Nitrogen rate (kg ha^{-1})								
0	0.51d	0.57d	1.31d	1.38d	1.67d	1.74d	1.80d	1.86d
70	0.84c	0.95c	1.77c	1.92c	2.38c	2.64c	2.49c	2.64c
140	1.05b	1.13b	1.97b	2.17b	2.59b	2.92b	2.75b	2.99b
210	1.21a	1.25a	2.14a	2.37a	2.76a	3.02a	2.94a	3.09a
SE±	0.015	0.014	0.028	0.027	0.028	0.025	0.034	0.020
Varieties								
California Wonder	0.85b	0.95b	1.67b	1.87b	2.23b	2.55b	2.43b	2.57b
Yolo Wonder	0.95a	1.00a	1.93a	2.05a	2.47a	2.61a	2.55a	2.72a
SE±	0.011	0.009	0.019	0.015	0.015	0.018	0.031	0.024
Interaction								
N X V	NS	NS	NS	NS	NS	NS	NS	NS

Means followed by same letter in a column and treatment group are not statistically different at 5% level of probability using DMRT. NS = Not significant; N = nitrogen, V = variety

Table 5; Net assimilation rate (NAR) per plant (g cm^{-2} wk^{-1}) of two sweet pepper varieties as influenced by nitrogen rate at sampling periods in 2012 and 2013 rainy season at Minjibir.

Treatments	**Net assimilation rate / plant** (g cm^{-2} wk^{-1})					
	4 – 6 WAT		6 – 8 WAT		8 – 10 WAT	
	2012	2013	2012	2013	2012	2013
Nitrogen rate (kg ha^{-1})						
0	2.14d	2.26d	2.52d	2.64d	2.62d	2.81c
70	2.37c	2.45c	2.79c	2.89c	2.81c	2.97b
140	2.48b	2.56b	2.92b	3.01b	3.00b	3.02b
210	2.54a	2.63a	3.00a	3.09a	3.15a	3.14a
SE±	0.019	0.014	0.021	0.018	0.042	0.036
Varieties						
California Wonder	2.27b	2.34b	2.71b	2.83b	2.80b	2.89b
Yolo Wonder	2.50a	2.60a	2.91a	2.98a	2.99a	3.08a
SE±	0.013	0.012	0.015	0.013	0.029	0.021
Interactions						
N X V	NS	NS	NS	*	NS	NS

Means followed by same letter in a column and treatment group are not statistically different at 5% level of probability using DMRT. NS = Not significant; * = Significant, N = nitrogen, V = variety.

Table 6 shows the significant interactions of N rates and sweet pepper variety on NAR at 6 - 8 WAT in 2013 at Minjibir. Significant increase in NAR per plant was observed with increase in nitrogen up to 210 kg ha^{-1} for the Yolo Wonder variety and with up to 140 kg ha^{-1} for the California Wonder which was statistically similar to those crops supplied 210kg N ha^{-1} treatment. The values of NAR recorded for Yolo Wonder were significantly more than for California Wonder at each of the N rate except at 140kg ha^{-1} when the two crops did not differ significantly. Yolo Wonder supplied 210kg N ha^{-1} gave the highest NAR values while the least was California Wonder variety at 0 kg N ha^{-1}.

Effects of nitrogen rate on yield and yield components of sweet pepper varieties

The influences of nitrogen rate on yields of two sweet pepper varieties at some sampling periods in 2012 and 2013 at

Minjibir in Sudan savanna of Nigeria are illustrated in Table 7. Application of nitrogen up to 140kg N ha^{-1} significantly influenced yield and yield components studied in this research especially fruit length in the seasons but peppers supplied 70 and 140 kg N ha^{-1} had statistically identical fruit width, number of fruits per plant and total fresh fruits yield (tons ha^{-1}).

Table 6; Interactions of nitrogen with variety on net assimilation rate (NAR) per plant (g cm^{-2} wk^{-1}) at 6 - 8 WAT in 2013 at Minjibir.

Nitrogen rates (kg ha^{-1}**)**	**Variety**	
	California Wonder	Yolo Wonder
0	2.52d	2.76c
70	2.81c	2.98b
140	3.00b	3.01b
210	3.00b	3.17a
SE ±	0.026	

Means followed by the same letter in the same interaction group are not statistically different at 5% level of probability using DMRT.

Table 7; Fruit length (cm). fruit width (cm), number of fruits per plant and total fresh fruit yield (ton ha^{-1}) of sweet pepper varieties as influenced by nitrogen rates in 2012 and 2013 rainy seasons at Minjibir.

Treatments	**Fruit length** (cm)		**Fruit width** (cm)		**Number of Fruits / plant**		**Total fresh fruit yield** (ton ha^{-1})	
Nitrogen rate (kg ha^{-1})	2012	2013	2012	2013	2012	2013	2012	2013
0	3.63c	3.67c	2.80b	2.54c	4.90c	5.30c	4.47c	4.90c
70	5.37b	5.38b	3.66a	3.72ab	7.78a	7.94a	8.06a	8.44a
140	5.90a	5.77a	3.85a	3.90a	7.69a	8.17a	7.75a	8.29a
210	5.15b	5.13b	3.49b	3.53b	6.48b	7.05b	6.56b	6.97b
SE±	0.095	0.113	0.068	0.080	0.260	0.184	0.265	0.198
Varieties								
California Wonder	5.34a	5.35a	3.56a	3.52a	7.48a	7.93a	7.53a	8.04a
Yolo Wonder	4.68b	4.63b	3.32b	3.31b	5.94b	6.30b	5.90b	6.25b
SE±	0.060	0.080	0.070	0.060	0.184	0.170	0.187	0.140
Interactions								
N X V	NS	NS	NS	NS	NS	NS	NS	NS

Means followed by same letter in a column and treatment group are not statistically different at 5% level of probability using DMRT. NS = Not significant; * = Significant, N = nitrogen, V variety.

Further increase to 210 kg N ha^{-1} depressed number of fruits per plant and fresh fruits yield (tons ha^{-1}) of the crops generally.

The results also showed that fruits of California Wonder had significantly greater lengths and diameters together with higher number of fruits per plant and total fresh fruit yield per hectare (tons) than Yolo Wonder variety in each year at Minjibir. No significant interaction was recorded for these yield and yield components.

DISCUSSION

The soils of the experimental farms at Minjibir in Sudan savanna of Nigeria were low in total nitrogen content (2.90 – 3.20 g kg^{-1}) as shown in the results of soil analysis so application of suitable amount of N fertilizers to these soils had caused higher growth and yields of sweet pepper varieties when compared with the control. This observation conforms to Jones and Wild (1975) who stated that the savanna soils of Nigeria are inherently low in available nitrogen. This has made application of correct levels of nitrogen to these savanna soils very important for higher yields from crops. Jain (2009) reported that most plants take up nitrogen from the soil and use it to

make chlorophylls, proteins, nucleic acids, vitamins, alkaloids, cytochromes, enzymes, etc. in their bodies for healthy development and heredity. Strochlein and Oebker (1979) discovered positive role of nitrogen in enhancing productivity of peppers since moderate rates of 100 - 150 kg N ha^{-1} produced more desirable growth and maximum fruit yields.

The significant increase in plant heights, shoot dry weight per plant, leaf area index (LAI) and net assimilation rate (NAR) per plant with increase in N rates to 140 or 210 kg ha^{-1} in this study is an indication that the crops' N requirements for these parameters were reached at either of these rates. Increase in LAI as a result of N application to these peppers had enhanced sufficient leaves surfaces exposed for good interception of sun light for use in assimilates productions through photosynthesis. Assimilates so produced were required for growths and developments of these crops as well as for higher yields. This, as earlier pointed out reveals that nitrogen is very crucial for the development of the photosynthesis machinery in plant especially the chlorophyll molecules for assimilates productions. These are in agreement with the reports from Olson *et al. (*1971); Epstein (1972) and Agbede, (2009).

The yield and yield components of sweet peppers like fruit diameter, number of fruits per plant, and total fresh fruit yield in tons per hectare measured in these trials were enhanced by nitrogen fertilizer applications at 70 or 140kg ha^{-1} in 2012 and 2013 at Minjibir. Ekwu and Okporie, (2000); Aman and Ishtiaq (2002) and Aminifard *et al*. (2002) reported similar results. Shafeek *et al.* (2012) made similar observations that the best sweet pepper growth and high total yield with nutritious fruits might be due to positive effect of N on the assimilatory vegetative parts that manufactured assimilates to make up pepper yield components and the overall pepper fruit yield.

The results obtained from this research that revealed Yolo Wonder to outperformed California Wonder in terms of the growth characters studied like plant height, dry weight, leaf area index (LAI) and net assimilation rate (NAR) at Minjibir in the two years of the research could be as a result of differences in their genetic make ups. Anonymous (2013b) stated that Yolo Wonder had more vigorous vegetative growth with dense foliage than the California Wonder which could probably mean that Yolo wonder variety had more innate capacity to harness substances within and outside the crop to build up its body structures than the California Wonder.

Yield and yield components such as total fresh fruit yield per ha, fruit length, fruit diameter, and number of fruits per plant of the two sweet pepper varieties in these trials at Minjibir in the seasons which were found to vary showed that California Wonder variety performed better probably because its assimilates productions favor fruits production and development rather than

vegetative growths. This is in line with observations of Paul and Vateva (2000), Jain (2009) and Hochmulth *et al.* (2014) that assimilates accumulated in parts of crops are usually converted to final fruit yields.

Thus from all the observations found from this trial, application of 70 kg N ha^{-1} to California Wonder variety could be recommended to farmers at Minjibir for higher fresh fruit yield of sweet pepper.

REFERENCES

Abdulmaliq, S. Y., Oluleye, F., Majin, N. S. and Isah, M. K. (2014). Effects of Nitrogen Levels and Harvesting Frequency on the Growth and Shoot Yield of *Solanum macrocarpon. Developmental Journal of Science and Technology Research,* 3(2): 177 - 184 pp.

Acquaah, G. (2004). *Horticulture-Principles and Practices.* 2nd edition. Prentice-Hall of India Private Limited, New Delhi-110 001. Pp. 694 - 695.

Agbede, O. O. (2009). *Understanding soil and plant nutrition.* Salmon Press and Co. Limited, Keffi, Nassarawa State, Nigeria. Pp. 1 - 259.

Aliyu, L. (2000). Effect of organic and mineral fertilizers on growth, yield and compositions of pepper (*Capsicum annuum* L.). *Biological Agriculture and Horticulture* 18 (1): 29 - 36.

Amadala V. (2016). How to achieve maximum Sweet Pepper Yield. Retrieved July 10, 2017 from http: // www.farmbizafrica.com

Aman, F. and Ishtiaq, M. (2002). Effects of different levels of nitrogen and plant spacing on the growth and yield of sweet pepper cv. Yellow wonder. *Sarhad Journal of Agriculture,* 18(3): 275 - 279.

Amans, E. B. (2011). Pepper varieties, Nursery and Requirements for successful enterprise. In: *Proceedings of the 2011 Preseason Training for Extension Staff in the North-west zone, Nigeria.* Pp 37 - 43.

Aminifard, F., Ishtiaq, M., Wadan, H. D. and Shah, M. (2002). Effects of different levels of nitrogen and plant spacing on the growth and yield of sweet pepper cv. Yellow Wonder. *Sarhad Journal of Agriculture,* Vol. 18(3) Pp. 275 - 279.

Aminifard M. H., Aroiee, H., Aziz M., Nemati H. and Jaafar H. Z. E. (2013). Effect of Composite on Antioxidant Component and Fruit Quality of Sweet Pepper (*CapsicumAnnuum* L.). *Journal of Central European Agriculture*, 14(2). Pp. 525 - 534.

Anonymous. (2012a). *Capsicum annuum* L.; Prota 2: Vegetables / Legumes. Retrieved April 05, 2012, from http:

//www.databaseprota.com and http: //www.gardenate.com

Anonymous. (2013b). Yolo Wonder Bell Pepper Plant. Retrieved July 07, 2013, from http: // www.davesgarden.com;www.localharvest.org; and www.learn2grow.com

Anonymous. (2014a). California Wonder. Retrieved July 10, 2014 from http: // www.mygardenlife.com ; www.myfolia.com; and www.amazon.com

Anonymous. (2014b). *Capsicum annuum* L. Retrieved July 07, 2014, from http://www.prota4u.org and How to Grow Yolo Wonder Pepper,http://www.heirloom-organic.com

Anonymous. (2015). Bell peppers. The world's healthiest foods. Retrieved July 9th, 2015 from http: //www.whfoods.com and www.mygardenlife.com

AOAC (1980). Official methods of analysis. Association of Official Analytical Chemists, Vol. 1, 15th ed. Washington D C: 72 - 843 pp.

Black, C. A. (ed) (1965). Methods of Soil Analysis 2.Chemical and microbiological properties. American Society of Agronomy. Madison, Wisconsin. 1972p.

Crosby, M. R. (2008). Pepper.Microsoft® Encarta® 2009 (DVD). Radmond, W. A.: Microsoft Corporation, 2008.

Ekwu, L. G. and Okporie, E. O. (2000). Effects of Plant Spacing and Nitrogen Fertilizer on the Growth and Yield of Pepper, *Capsicum annuum* L. *Journal of Agriculture, Food Environment and Extension,* Vol. 3(2). Pp. 1 – 4.

Epstein, E. (1972). Mineral nutrition of plants: Principles and perspectives. John Wiley and sons New York. Pp. 10 - 74.

Gomez, K. A. and Gomez, A. A. (1984). *Statistical Procedure for Agricultural Research.* 2nd edition. John Wiley and Sons Inc., Singapore. 680p.

Grundberg, E. (2014). A Pepper Primer - Introducing the *Capsicum*. USDA National Institute for Food and Agriculture, US; Pp. 1 - 23.

Havlin, J. L., Tisdale, S. L., Beaton, J. D. and Nelson, W. L. (2006). *Soil Fertility and Fertilizers – An Introduction to Nutrient Management.* Seventh edition. Prentice-Hall of India Private Limited, New Delhi – 110 001. Pp. 97-115.

Hochmulth, G., Maynard, D., Vavrina, C., Hanlon, E and Simonne, E. (2014). Plant Tissue Analysis and Interpretation for Vegetable Crops in Florida. *Electronic Data Information Source of UF/IFAS Extension.* Publication # HS964.

Hoven, M. (2013). Do Red Bell Peppers Burn Fat? Metabolic Profiling. www.livestrong.com Retrieved on August 25th, 2013.

Jain, V. K. (2009). *Fundamentals of Plant Physiology.* 12th edition. S. Chand & Company Ltd, Ram Nagar, New Delhi, India. 110055. Pp. 112-162.

Jones, M. J. and Wild, A. (1975). Soils of the West African Savannas. Technical Communication No. 55, Common Wealth Bureaux of Soils, Harpenden, Herts.

Lawal, A. O. and Fagge, A. A. (2011). Economic Importance, Harvesting and Post- Harvest handling of Pepper. In: *Proceedings of 2011 Pre-season Training for Extension Staff in the North-west Zone, Nigeria.* Pp. 53-69.

Malik, A. A., Chattoo, M. A., Sheemar, G. and Rashid, R. (2011). Growth, yield and fruit quality of sweet pepper hybrid SH-SP-S (*Capsicum annum* L.) as affected by integration of inorganic fertilizers and organic manures (FYM). *Journal of Agricultural Technology.* Vol. 7(4): 1037-1048.

Nadeem, M., Anjum, F. M., Khan, M. R., Saeed, M. and Raiz, A. (2011). Antioxidants Potentials of Bell Pepper (*Capsicum annuum* L.) – A Review.PAK. J. FOOD SCI. 21(1-4): 45-51.

Olaniyi, J. O. and Ojetayo, E. A. (2010). The effects of organo-mineral and inorganic fertilizer on the growth, yield and fruit quality of pepper (*Capsicum frutescens* L.). *Journal of Animal and Plant Science* Vol. 8(3): 1070 - 1076.

Olson, R. A., Amy, J. J., Hanway, J. J. and Kilmer, U. J. (1971). Fertilizer technology and use. 2nd ed. Soil Science of America Inc. Madison. Pp. 217.

Paul, W. B. and Vateva, E. J. (2000). Peppers, vegetables and species of capsicum. In crop Production science in Horticulture 12 CABI publishing Willing food, Oxio, UK. P. 118.

Reddy, C. (2012). The Earth of India: All About Capsicum in India. www.blogspot.com Retrieved on December 29th, 2014.

Rice, R. P., Rice, L. W. and Tindall, H. D. (1987). *Fruit and Vegetable Production in Africa.* MacMillan Publishers Ltd, Hong Kong China. Pp. 231 - 233.

Shafeek, R., Ngwa, M. K., Awatef, H., Beheiry, G. and Rizk, F. A. (2012). Productivity of sweet pepper (*Capsicum annuum* L.) as affected by different nitrogen sources and sulphur fertilizers under newly reclaimed soil. *Journal of Applied Sciences Research,* 8(11): 5365 - 5371.

Singh, R. V. and Naik, L. B. (1990). Effects of nitrogen, phosphorus and plant spacing on sweet pepper (*Capsicum annuum* L.). *Haryana Journal of Horticultural Sciences* Vol. 19(1-2):

168-172.

Steel, R. G. and Torrie, J. W. (1984). *Principles and Procedure of Statistics: A Biometrical Approach.* Second ed. MacGraw-Hill Intern. Books, Auckland. Pp. 633.

Strochlein, J. L. and Oebker, N. F. (1979). Effects of nitrogen and phosphorus on yield and tissue analysis of Chilli pepper. *Horticultural Sciences Journals,* 311: 1125-1184.

Udo, I. A., Uguru, M. I.and Obuji, R. O. (2004). Pathogenicity of *Meloidogyne incognita* race on Nigeria pepper (*Capsicum spp)* Lines. In *Proceedings of the 22nd annual conference of the Horticultural Society of Nigeria.* 2004. Pp. 107 - 111.

United States Department of Agriculture (USDA). (2011). World bell and Chile peppers : Productions 1990 - 2007. Wikipedia, the free encyclopedia.

Faculty of Agriculture, Ibrahim BadamasiBabangida University, Lapai 2022
Lapai International Journal of Agriculture Vol. 3(1) June,2022 pp 649-657
ISSN:2705-2869

Effects of Different Land Uses on Profile Properties of Alfisols in Southern Guinea Savanna

Abdulmaliq, S. Y[1] ., Olaniyan, J. O[2]., Isimikalu, T. O[2] and Majin, N. S[1]

1. Department of Crop Production, IBB University, P. M. B. 11, Lapai, Niger State Nigeria
2. Department of Agronomy, University of Ilorin, P. M. B. 1515, Ilorin, Nigeria

ABSTRACT

A soil profile pit each was dug in two fallow land under Gmelina arborea and natural bush fallow at the southern guinea savannah in the University of Ilorin, Teaching and Research farm to evaluate the effects of different land uses on the physical, chemical and morphological properties of the soils. Samples were collected from each profile at different depths and later condensed to form surface and subsurface soil samples. The result of the analysis shows that the physical and morphological properties were not affected by the land use system. Also, the Ca, K, Mg, Na, total acidity and base cation saturation (BCS) were not significantly affected by the profile depth (surface and subsurface). However, the soil reaction (pH) and effective exchangeable cations were significantly affected by soil depths.

Keyword: soil profile, Gmelina arborea, bush fallow, natural bush, land uses

Faculty of Agriculture, Ibrahim BadamasiBabangida University, Lapai 2022
Lapai International Journal of Agriculture Vol. 3(1) June,2022 pp 649-657
ISSN:2705-2869

INTRODUCTION

Land degradation is a major problem in many parts of the tropics (Hartman 1981). This has been recognized as a major factor contributing to low agricultural productivity in sub-sahara Africa (Sanchez, 2002; Vanlauwe and Giller, 2006). This is due to over exploration of vegetation and adoption of inappropriate methods of farming. Therefore, there is a need to increase the sustainable agricultural productivity of land with acceptable inputs to meet increasing human needs while maintaining the soil resource base and minimizing environmental degradation.

Agboola and Ayodele (1985) have shown that the soil degradation under some traditional farming systems is on the increase in the tropics and to reclaim the degraded soil through traditional fallow technique has not been easy because of the high demand for land and the relatively long fallow periods required. Woody trees play an important role in increasing fertility status of soils under its stand by providing adequate litter falls and decomposition by soil biota to return nutrients back to the soil for use (Diack *et al.,* 2000).

Gmelina arborea is a short live woody tree that has been found to improve physical, chemical and biological properties of soil and can regulate the flow of soil nutrient (Kang *et al.,* 1990). The soil fertility status depends on the amount and availability of essential nutrient elements for plant growth and development (Lombin, 1999). The study aimed at evaluating the physical, chemical and morphological properties of soil under *Gmelina arborea* fallow and compares it with those under natural fallow with a view to understanding the potential of *G. arborea* in ameliorating soil fertility status

MATERIALS AND METHODS

Description of the experimental sites

The study was carried out in May 2020 at the Agro-forestry Establishment of the University of Ilorin Teaching and Research farm located at 8°27'0.89"N 4°39'47.97"E (Figure 1), on an elevation of approximately 310 m above sea level. The study area falls within the southern Guinea savanna zone of Nigeria.

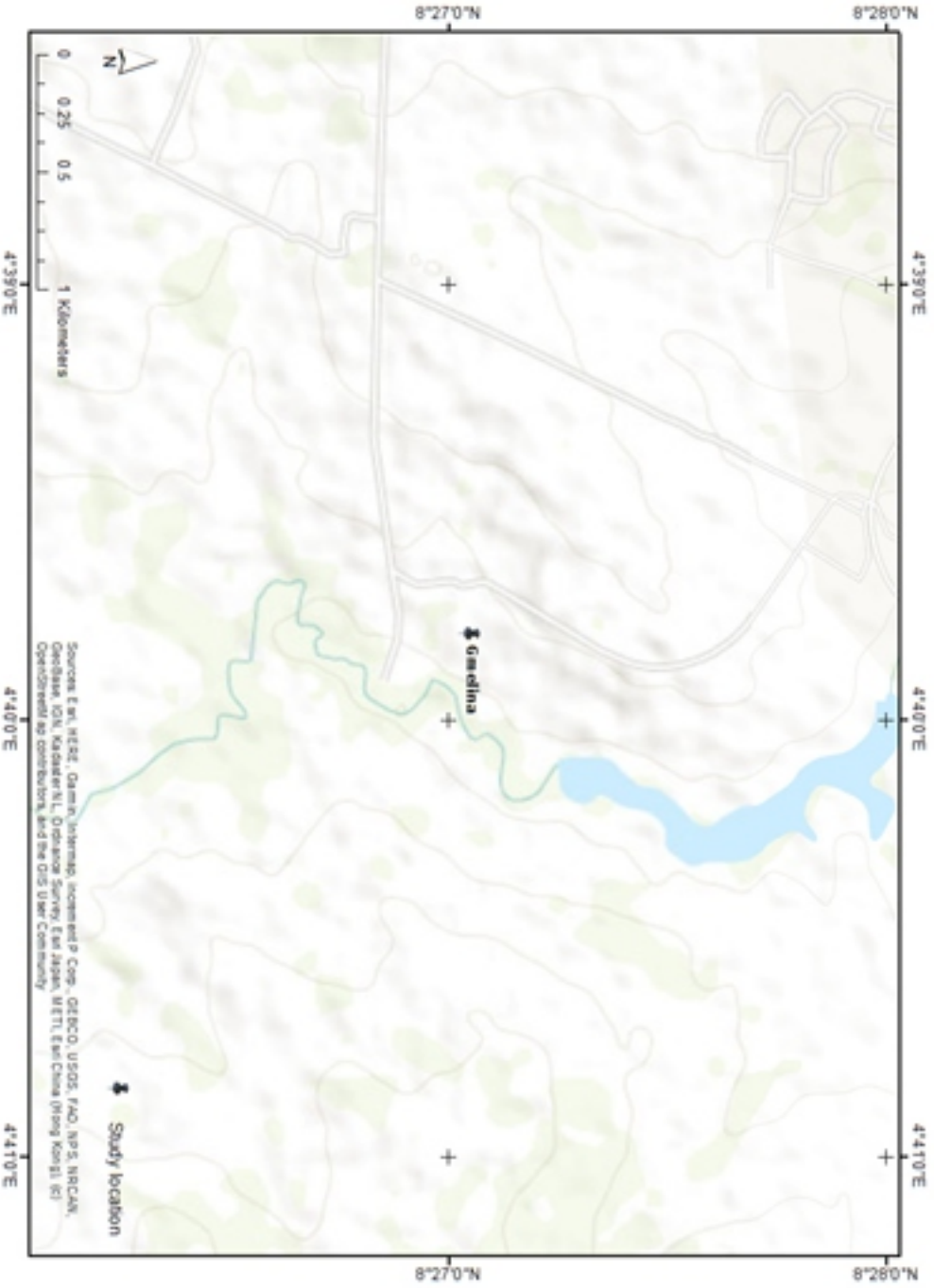

Figure 1. The study location

The Study Area

Soil sampling and analysis

A soil profiles pit was dug on sites representing each of the two identified fallow system (*Gmelina arborea* and Natural fallow land). The profile pits were described following FAO 1980 guideline and soil samples were taken from each pedogenic horizon for laboratory analysis as follows;

- Particle size distribution was analysed using hydrometer method and textural class was determined by the soil textural triangle.
- Soil pH was determined in water by using a soil solution ratio of 1:2.5 by means of a Philip analogue pH meter.
- Available phosphorus was determined by Trough method. The extracted phosphorus was determined by the molybdate blue colour method (Bremner, 1996).
- The exchangeable bases, calcium (Ca) magnesium (Mg) potassium (K) and Sodium (Na) were extracted using IN acetate (pH 7.0).
- Percentage organic carbon (OC)was determined using Walkley - Black method (IITA, 1979). Percent organic matter (OM), was determined by multiplying product of organic carbon with 1.724 (Hoyle *et al.,* 2011);
  OM= OC x 1.724.
- Effective cation exchange capacity (ECEC) was determined by summation of basic cations and exchangeable acidity

The horizon from each profile were condensed into surface and subsurface soils for statistical analysis. All data collected were subjected to analysis of variance (ANOVA), significant means were separated using $LSD_{(0.05)}$

RESULTS

The result of physical, chemical and morphological properties of the two sites studied is presented in table 1. The result reveals that there were no variations in the textural classes of the two sites (*Gmelina* and natural bush fallow). The two sites textural class were dominated with sandy loam. Although there were some variations in the percentage clay, silt and sand in the various depths and the two sites. The surface layers contained more sand than the subsurface layers in the two sites and the reverse is the case in the subsurface layer.

Similarly, the soil colour under *Gmelina arborea* and natural bush fallow shows common colours in the 10YR hue with the values ranging between 4 - 8 for the *Gmelina* and 5-8 chrome for natural bush fallow at different layer. Thus, the *Gmelina* site possess colour ranging from dark brown at the surface and brownish yellow at the subsurface layers while the natural bush fallow possesses pale brown at surface to very pale brown at the subsurface layers. In another vein, the soil reactions in the two sites were generally ranging between slightly acidic to moderately alkaline. The pH under *Gmelina* ranges between 4.9 -8.1 while under the natural bush fallows 6.4 – 7.7.

There were no significant differences

among the surface and subsurface soils of the two pits in the quantities of organic matter content (OM%), calcium (Ca), potassium (K), magnesium (Mg), sodium (Na), total acidity (TA), percentage basic cation saturation (BCS%) and total available phosphorus(P). However, *Gmelina* pit had higher percentage of organic matter (1.3500), higher calcium (2.14 cmol/kg)), potassium ((0.910 cmol/kg) and Magnesium (2.97 cmol/kg) when compared with natural bush fallow as shown in (Table 2). Also, the effective cation exchange capacity (ECEC) in all depths were higher than the critical value of 4 cmol/kg of soil for the tropical soils.

DISCUSSION

The higher sand particles in the soil surface in the two samples can be attributed to the nature of savanna soils and to the fact that under plantation, leaching activities are higher, bulk density lower and total porosity is higher, these may lead to downward movement of material like silt and clay. This is in line with Obi (1999) which stated that particle size distribution is a permanent component of the soil and does not change much with time.

The dark brown colour of the surface layer in the *Gmelina* site can the attributed to the high percentage of organic matter obtained from the leaf litter mineralization. This agrees with Aduradola *et al. (*2005), who reported that the mineralization of leaves usually improves the quality of the top soil

The low pH under *Gmelina* can be attributed to the presence of microorganisms on the surface that acts on leaf litter, while the higher pH of the natural bush fallow. This result is in line with Ota - Henry *et al.* (2018) who reported lower pH in Soils with Gmelina plantations and higher pH Gmelina free area. This can also be as a result of the penetration of the roots of *Gmelina arborea* into the soil profile passing through the topsoil to the subsoils layers which tends to increases the root inputs on the soil (Rumpel and Kögel-Knabner, 2011). The plant root system releases some exudates wish enhances formation of soil organic matter, while the efficient utilization of exudates by microorganisms through the conversion of root exudates to biomass and secondary by-products contributes to effective soil stabilization and retention of soil minerals as reported by Bradford *et al.,* (2013). Furthermore, the mycorrhizal type of deep roots is a key driver in the accumulation of soil organic carbon within the rhizosphere (Phillips *et al.,* 2013). Also, Ota-Henry *et al.* (2018) reported that *Gmelina* and *Gliricidia* plantation have the capacity to protect the soil, restore degraded soil, conserve soil moisture and ensure nutrient cycling through the soil plant system., Furthermore, *Gmelina* and *Gliricidia* plantation improved organic matter and humus which enhanced the activities of micro-organism which act on the humus to release water and nutrient which could be absorb directly by plant. The high value of ECEC can be attributed to the degree of weathering and leaching processes as described by (Kang *et al*. 1991). The ECEC under natural bush

fallow was significantly higher than the ECEC under the *Gmelina arborea* as shown in Table 2.

CONCLUSION AND RECOMMENDATION

The results of the experiment show that the *G. arborea* site is lower in soil pH and Higher in percentage organic matter when compared with natural bush fallow, as a result of the accumulated leaf litters deposition on the soil surface. It is therefore recommended that sites with *Gmelina arborea* should be used for the production of arable crops and in areas where there are problems of high salinity.

REFERENCES

Agboola, A.A. and Ayodele, O. J. (1985) Prospects and Problems of Using Soil Testing for Adoption of Fertilizer Use in Ekiti –Akoko Agricultural Development Project Area. Proceedings of Workshop on Appropriate Technologies for Farmers in Semi- Arid West Africa.Purdue University, West Lafeyete.pp 123-136.

Bremner J. M. (1996). *Nitrogen -Total.* In: Sparks, D.L. (ed). Methods of Soil Analysis: Chemical Methods. Part 3. Soil Sci. Soc. Am. Book Series No. 5. ASA-SSSA, Madison, WI.

Diack, M., Badiane, M. A. and Diatta, M. (2000) Decomposition of native shrub *Piliostigmareticulatum* litter in Soil of Semiarid Senegal. *Agricultural Reseach Institute of Senegal*

FAO (1980) Forestry Volume and Yield Production.Volume Estimation. FAO Forestry Paper 22/1196. $NaHCO_3$ Extracting Solution. Laboratory Manual. ISRFL.NCSU, Raleigh, NC 39pp

Hoyle, F. C., Baldock, J. A., & Murphy, D. V. (2011). Soil organic carbon - role in rainfed farming systems: with particular reference to Australian conditions. In P. Tow, I. Cooper, I. Partridge, & C. Birch (Eds.), *Rainfed Farming Systems* (pp. 339-361).

IITA, (1979). Selected Methods of Soil and Plant Analysis.Manual Series NO 1. IITA, Ibadan.

Kang, B. T., Gichuru, M., Hulugalle, N. and Swift, N. J. (1991) Soil constraints for Sustainable Upland Crop Production in Humid West Africa. Proceedings of the International Symposium of Tropical Agriculture Research Centre, Tsukuba, Japan. pp.101-112.

Kang, B. T., Reynolds, I. and Attah- Krah, A. N Alley Farming. *Adv. Agron.* 43: 315-359.

Lombin, G. (1999) *Soil Science: Introduction to tropical Agriculture,* Longman group ltd, England Pp.42-50.

Sanchez, P. A. (2002). Soil fertility and hunger in Africa. *Science* 295:2019–2020.

Vanlauwe, B. and Giller, K. E. (2006). Popular Myths Around Soil Fertility Management in Sub-Saharan Africa. *Agricultural Ecosystem and Environment,* 116:34-46.

Table 1: Physical, chemical and morphological properties of soil profiles

Profile Pit	Depth (cm)	% Sand	% Silt	% Clay	Textural class	Soil colour	pH (1:1 H_2O)	% OM	Ca^{2+}	K^+	Mg^{2+} (cmol (+)/kg)	Na^+	TA	ECEC	Av. P (mg/kg)	% BS
1	0-20	75.36	16.00	8.64	Sandy Loam	10YR4/3 (DB)	4.9	1.71	3.15	2.66	1.26	0.43	0.35	7.85	19.81	95.5
	20-35	89.36	18.00	10.64	Loamy sand	10YR 5/8 (YB)	5.9	0.99	1.12	3.28	0.56	0.61	0.50	16.10	9.18	95.8
	35-60	67.36	16.00	16.64	Sandy Loam	7.5YR 6/8 (SB)	7.1	0.61	1.26	2.46	0.42	0.43	0.75	5.32	14.14	85.9
	60-90	61.36	20.00	18.64	Sandy Loam	10YR 6/8 (BY)	8.1	0.38	1.33	1.23	0.28	0.43	0.85	4.12	10.01	85.9
2	0-25	77.36	12.00	10.64	Sandy loam	10YR 6/3 (PB)	6.7	1.24	1.33	2.87	0.70	0.52	1.55	6.97	17.22	77.8
	25-55	77.36	12.00	10.6	Sandy Loam	10YR 5/8 (YB)	7.1	0.89	0.84	2.97	0.63	0.52	0.70	5.66	15.16	87.6
	55-90	75.36	12.00	10.64	Sandy loam	7.5YR 5/6 (W)	6.4	0.88	0.63	2.97	0.63	0.52	1.80	6.55	12.22	72.5
	90-120	61.30	30.00	8.64	Sandy loam	10YR 8/2 (W)	7.1	0.60	1.05	2.87	0.35	0.35	0.25	4.87	7.77	94.9
	120-150	89.36	18.00	10.64	Loamy sand	10YR 8/4 (VPB)	7.7	0.36	1.40	2.46	0.70	0.43	2.95	7.94	2.24	82.8

D=Dark; B=Brown; Y=Yellow; S= Strong; P=Pale; W=White: V=Very

Table 2: Physical and chemical properties of surface and subsurface soils of profile pits

Properties	Depth	***G. arborea***	**Natural Bush fallow**	**SE±**	**LSD**
pH	Surface	5.40b	6.90a	0.23	0.456
	Subsurface	7.10b	7.75a	0.32	0.642
% OM	Surface	1.35	1.07	0.18	ns
	Subsurface	0.49	0.74	0.24	ns
K (cmol (+)/kg)	Surface	0.91	0.67	0.223	ns
	Subsurface	0.35	0.49	0.117	ns
Ca (cmol (+)/kg)	Surface	2.14	1.09	0.85	ns
	Subsurface	1.30	0.84	1.22	ns
Mg (cmol (+)/kg)	Surface	2.97	2.92b	0.62	ns
	Subsurface	1.85	2.92	0.88	ns
Total acidity (cmol (+)/kg)	Surface	0.43	1.12	0.64	ns
	Subsurface	0.80	1.03	0.92	ns
ECEC (cmol (+)/kg)	Surface	6.96a	6.32b	0.224	0.447
	Subsurface	4.72b	5.71a	0.32	0.632
% BS	Surface	93.7	82.7	10.5	ns
	Subsurface	82.7	83.7	14.99	ns
Available P (mg/kg)	Surface	17.95	16.19	8.51	ns
	Subsurface	12.08	10.01	1.204	ns

Faculty of Agriculture, Ibrahim BadamasiBabangida University, Lapai 2022
Lapai International Journal of Agriculture Vol. 3(1) June,2022 pp 658-669
ISSN:2705-2869

Insect Pests Diversity on Cultivated Vegetables at Bakajeba Dry Season Irrigation Site of Lapai-Agaie Dam Niger state, Southern Guinea Savannah

Solomon Danjuma, Abubakar Mohammed Ndako Suleiman Majin and Musa Mahmud Mundi

Department of Crop Production, Faculty of Agriculture, Ibrahim Badamasi Babangida University, P. M. B. 11, Lapai, Niger State.
Correspondence email: sdanjuma@ibbu.edu.ng

ABSTRACT

Insect pest remains one of the major biotic factors responsible in limiting the productivity of vegetables on a global scale. Vegetables cultivation has been on the increase due to human population explosion and request for this irreplaceable food also increased tremendously. This has been attended by serious insect pests. This present research, carried out from January – April, 2020, was aimed at identifying insect pests attacking vegetables grown at Bakajeba dry season irrigation (Lambu) at the bank of Lapai-Agaie Dam, Niger state, Nigeria. Four vegetable farms were selected at random and four vegetable crops were selected which were predominantly cultivated at this dam site. These vegetables include okra (*Abelmoschus esculentus*), *Amaranthus* Spp., sweet pepper (*Capsicum frutescens*) and Eggplant (*Solanum melongena*). Insect pests were collected with the aid of yellow sticky board, sweep net, handpicking and dissecting and screening of infested plant parts. A total of 23 insect species belonging to 12 families and 5 orders were recovered. Among these lots, 8 insect pests were general feeders while others were specific to the various vegetables examined. More interestingly, thrips were found to be occupying the flowers of sweet pepper which pose a serious control pressure and exert immense damage and subsequently attended low yield. The results accrued in this study will served as handy information for agencies and Government concerned with insect pests control.

Keywords: Diversity, Insect pests, Dry season irrigation, Vegetables, Yellow sticky board, Sweep net

Faculty of Agriculture, Ibrahim BadamasiBabangida University, Lapai 2022
Lapai International Journal of Agriculture Vol. 3(1) June,2022 pp 658-669
ISSN:2705-2869

INTRODUCTION

Vegetables are indispensable part of our diet, supplying vitamins, carbohydrates and minerals needed in a balanced diet. Their value is important especially in developing countries like Nigeria, where malnutrition is a major problem among children and adults. Vegetables are generally economic crops however, for the past one decade there has been a sharp rise in the demand and consumption of Amaranth (Bosch *et al*., 2009). This can be attributed to increased awareness on the importance of vegetable as a valuable source of food, medicine and income for small-scale farmers (Maundu *et al*., 1999 and Ouma, 2004). There is a growing need among farmers in Nigeria to diversify agricultural production especially vegetable production, in this case, shift from over-reliance on exotic vegetables and grow more African Leafy Vegetables that include both indigenous and traditional vegetables is intensified (Mbugua *et al*., 2005).

The main constrain is that there is limited research that has been put in place to enhance production of African Leafy Vegetables (Ouma, 2004) and vegetables as a whole. As many vegetable productions face a major challenge due to pest infestation. Over-reliance on organochlorines and organophosphates or their derivatives as a control strategy for pests is facing resistance due to rising impact on the environment and health of human beings and their animals (Sithanantham, 2004 and Losenge, 2005). Use of biological control agents, pesticides derived from natural sources (Botanicals), cultural control of pest and judicious use or complete abstinence from persistent pesticides is the way forward in the management of insect pests of vegetables (Losenge, 2005). Keeping the above facts in view, the present investigation entitled "Insect Diversity on Cultivated vegetables at bakajeba irrigation site with specific reference to okra (*Abelmoschus esculentus),* Amaranthus Spp**.** ***(****Amaranthacea),* pepper *(Capsicum frutescens)*, Eggplant *(Solanum melongena)*" was conducted during the dry season 2020.

Materials and Methods

The study was carried out at Bakajeba irrigation site, from January to April of the year 2020. Bakajeba is situated in Niger state, Nigeria and it geographical coordinates are 9◦ 14′ 0″ North, 6◦ 34′ 0″ East, and the irrigation site located at 9◦ 13′ 40″ N, 6◦ 33′ 25″ E. with an annual rainfall range of 1100 - 1650mm and the relative humidity ranges between 70% - 90% (IBBU Geographical Weather Station, 2020) on the average.

Sample site

The farms were chosen based upon the following conditions: the growers' willingness to partake in the experiment, the presence of green vegetables in the field, and a distance of at least 50m

separating each farm from one another. Four farms were selected from the irrigation site. Farm sizes ranges from 0.25 - 0.5ha. The common vegetables grown on the farms were okra (*Abelmoschus esculentus*), *Amaranthus* Spp., pepper (*Capsicum frutescens*) and Eggplant (*Solanum melongena*). Data were collected accordingly on all these vegetables for the period of the study (January – April). There were little or no vegetation surrounding the farms as this site was for dry season irrigation.

Material used in the collection of the insect pests

During the course of sample collections, the materials used were yellow sticky board, sweep net, rubber bows for pit fall, light traps, leather zip pack and vials of 10 to 50 ml containing 75% alcohol. Styrofoam boxes of varying sizes were also used to carry the materials and collected samples to and from the field, respectively.

Sample collection

Three Yellow sticky board traps were placed diagonally at 10m distance for two weeks (14 days) in each of the vegetable farm against wind direction. Insects were also hand-picked, especially crawling and poor fliers. Sweep-net was also used during every visit to the farms to collect slow / fast flying insects. Nets were swung over each farm for at least a period of 30 minutes at every visit time. Five pit fall traps were set at intervals of 5 m per farm and detergent liquid kept in a rubber bow placed to fit into each pit dug. Four light traps were also set on each farm to arrest nocturnal insects. A light trap was placed at the center of each farm at a distance of 0.3 – 0.5 ha activated with the aid of rechargeable touch light directed at a bow of water. Damage plant parts were also collected from the plant and place in zip-packs. All collected insects were kept in vials containing 75% alcohol and placed in the Styrofoam box and transported to the laboratory.

Identification of insect pest and mounting in insect boxes

Identification of the insects sampled was done using the morphological characters detailed in some texts. Monographs of insects were also used, hand lens and light microscope were used to confirmed minute and conspicuous detailed characters on the insect specimens. The insects were then prepared for placement in insect boxes. Insects were mounted in the boxes in their respective orders and species detailed accordingly for convenient referencing.

Depositing of the identified samples voucher

All specimens mounted in the boxes, those in alcohols vials and on the sticky boards were deposited at the reference section of the Entomology Unit of the Department of Crop Production, Ibrahim Badamasi Babangida University, Lapai, Niger state.

Data Analysis

No any form of statistical analysis was carried out in this present study as it only entails the checking and confirmation of the insect pests of vegetables for the first time at the present study sites. All insects collected at the present study sites were only presented generally in a table defining their species, families and orders. Also specific insects on each vegetable studied for the period were presented in tables and species richness among the vegetables determined. Comparison was also carried out with what has been collected elsewhere in Niger state and Nigeria at large.

RESULTS

Insect pests of vegetables occurring in the study site

A total of twenty-three (23) insect species, belonging to twenty (20) families and eight (8) orders were revealed from the study (Table 1). The eight orders of insects recorded were listed with the number of species revealed in brackets; Hemiptera (9), Coleoptera (4), Lepidoptera (4), Diptera (2), Heteroptera (1), Orthoptera (1), Thysanoptera (1) and Isoptera (1) were recovered from the study (table 1).

Faculty of Agriculture, Ibrahim BadamasiBabangida University, Lapai 2022
Lapai International Journal of Agriculture Vol. 3(1) June,2022 pp 658-669
ISSN:2705-2869

Table 1: Record of insect pest recovered on vegetables during the research period

S/n	Insect pest	Scientific names	Order	Family
1.	Aphids	*Aphis gossypii* .Glover	Hemiptera	Aphididae
2.	Whitefly	*Bemisia tabacii.* Gennadius	Hemiptera	Aleyrodidae
3.	Green Stink bug	*Nezara viridula.* L.	Hemiptera	Pentatomidae
4.	Cotton strainers	*Dysdercus fasciatus.* Guerin-Méneville	Hemiptera	Pyrrhocoridae
5.	Cotton seed bug	*Oxycarenus hyalinipennis.* A. Costa	Hemiptera	Lygaeidae
6.	Shield bug	*Sphaerocoris annulus.* F.	Hemiptera	Scutelleridae
7.	Spittle bug	*Poophilus costalis.* Walker	Hemiptera	Aphrophoridae
8.	Stink bug	*Agonoscelis vesicolor.* Spinola	Hemiptera	Pentatomidae
9.	Cotton helopeltis	*Heliopeltis Schoutedeni* Signoret	Hemiptera	Miridae
10.	Coreid bug	*Anoplocnemis Curvipea.* F.	Heteroptera	Coreidae
11.	Fruit borer	*Helicoverpa Armigera.* Hübner	Lepidoptera	Noctuidae
12.	Cotton leaf roller	*Sylleptae derogata.* F.	Lepidoptera	Pyralidae
13.	Cotton leaf worm	*Spodoptera littoralis.* Boisduval	Lepidoptera	Noctuidae
14.	Cotton bollworm	*Helicoverpa armigera.* Hübner	Lepidoptera	Noctuidae
15.	Leaf eating beetles	*Lagria villosa.* F.	Coleoptera	Lagridae
16.	Flea beetles	*Podagrica* spp. Foudras	Coleoptera	Chrysomelidae
17.	Lady bird beetles	*Cheilomenes sulphurea.* Olivier	Coleoptera	Coccinelloidea
18.	Flower beetles	*Mylabris* spp. F.	Coleoptera	Meloidae
19.	Green Blowfly	*Lucilia sericata.* Meigen	Diptera	Calliphoridae
20.	Pepper fruit fly	*Artherigona orientalis.* Schiner	Diptera	Muscidae
21.	Termites	*Various* spp. (Brullé)	Isoptera	Termitidae
22.	Variegated grasshopper	*Zonocerus variegatus.* L.	Orthoptera	Pyrgomorphinae
23.	Thrips	*Thrips simplex.* Morison	Thysanoptera	Thripidae

Insect pests recorded on okra plant for the period of the study

Insect pests recorded on okra for the period of the study is presented in table 2. A total of 10 species were recorded belonging to 9 families and 4 orders (table 2). All recovered insect species were all major pests causing significant damage to okra plant.

Table 2 Record of insect pest found on okra during the study period

S/n	Insect pest	Scientific names	Order	Family
1.	Aphids	*Aphis gossypii.* Glover	Hemiptera	Aphididae
2.	Stink bug	*Agonocellis vesicolor.* Spinola	Hemiptera	Pentatomidae
3.	White fly	*Bemisia tabacii.* Gennadius	Hemiptera	Aleyrodidae
4.	Cotton stainer	*Dysdercus fasciatus.* Guerin-Méneville	Hemiptera	Pyrrhocoridae
7.	Flower beetles	*Mylabris spp.* F.	Coleoptera	Meloidae
	Flea beetles	*Podagrica spp.* Foudras	Coleoptera	Chrysomelidae
	Ladybird beetles	*Cheilomenes sulphurea.* Olivier	Coleoptera	Coccinellidae
8.	Leaf roller	*Sylleptea derogate.* F.	Lepidoptera	Noctuidae
9.	Fruit borer	*Helicoverpa Armigera.* Hübner	Lepidoptera	Noctuidae
10.	Variegated grasshopper	*Zonocerus variegatus.* L.	Orthoptera	Pyrgomorphidae

Insect pests recorded on pepper during the research period

The insect pests of pepper recorded for the period of the study were presented in table 3. A total of 5 species belonging to 5 families and 3 orders were recovered from the pepper farm during the study. Apart from other species which could be of lesser problem to pepper production, thrips were found to pose serious problem to pepper production and hence, it was the major insect pest observed for the period of the study. The thrips were found occupying the flower and could not be reached with synthetic chemicals sufficiently

Table 3 Record of insect pests found on pepper

S/n	Common names	Scientific names	Order	Family
1.	Aphids	*Myzus persica.* Sulzer	Hemiptera	Aphididae
2.	Cotton helopeltis	*Helopeltis schoutedeni* Router	Hemiptera	Miridae
3.	White flies	*B. tabacii.* Gennadius	Hemiptera	Aleyrodidae
4.	Pepper fruit fly	*Atherigona orientalis.* Schiner	Diptera	Muscidae
5.	Thrips	*Thrips simplex.* Morison	Thysanoptera	Thripidae

Insect pests of amaranths recovered during the study

Insect pests of amaranths recovered during the study period are presented in table 4. A total of 6 species belonging to 5 families and 3 orders were caught (Table 4). Among the insects, the order Hemiptera presents more species than the other orders (Table 4). The hemipterous species presented here are of more economic importance with reference to amaranths production at the study site.

Table 4 Record of insect pest found on Amaranths during the research period

S/n	Common names	Scientific names	Order	Family
1.	Green stink bug	*Nizara viridula.* L.	Hemiptera	Pentatomidae
2.	Stink bug	*Agonoscelis versicolor.* Spinola	Hemiptera	Pentatomidae
3.	Spittle bug	*Poophilus costalis.* Walker	Hemiptera	Aphrophoridae
4.	White fly	*Bemisia tabacii* Gennadius	Hemiptera	Aleyrodidae
5.	Leaf eating beetles	*Lagria villosa.* F.	Coleoptera	Lagridae
6.	Variegated grasshopper	*Zonocerus variagatus* L.	Orthoptera	Pyrgomorphidae

Insect pests of egg plant recorded during the study

Insect pests of egg plant recovered at the study site are presented in table 5. The sum of 8 species belonging to 8 families and 4 orders were observed during the study (table 5). The Hemipteran and Lepidoteran orders presents the highest number of insects in this study (Table 5). The species presented under the two orders are major insect pests of eggplant.

Table 5 Record of insect pest found on eggplant during the research period

S/n	Common names	Scientific names	Order	Family
1.	Aphids	*Aphis gossypii* Glover	Hemiptera	Aphididae
	White fly	*Bemisia tabacii* Gennadius	Hemiptera	Aleyrodidae
	Cotton strainer	*Dysdercus superstitiosus* Guerin-Mêneville	Hemiptera	Pyrrhocoridae
2.	Shoot and fruit borer	*Leucinodes orbonalis* Guenêe	Lepidoptera	Crambidae
3.	Fruit borer	*Earias* spp. Hubner	Lepidoptera	Nolidae
4.	Eggplant leaf roller	*Eublemma olivacea* Walker.	Lepidoptera	Noctuidae
5.	Flea beetles	*Podagrica* spp. Foudras	Coleoptera	Chrysomelidae
6.	Variegated grasshopper	*Zonocerus variegatus* L.	Orthoptera	Pyrgomorphidae

DISCUSSION

Development times of insects are influenced by temperature, relative humidity, and diet (Subramanyam and Hagstrum, 1993). Temperature and relative humidity had an effect on the population of all kinds of insects. As the temperature and humidity in 2020 was high, it had caused quick and big explosions of insect's population (Sedaratian *et al*., 2010). However, the distribution of many insect species is limited by temperature (Khan *et al*., 2008). Insects cannot develop below a threshold of temperature and they need to accumulate enough day degrees to complete their life cycle (Lamb, 1992; Gilbert and Raworth, 1996; Addo-Bediako *et al*., 2000; Danks, 2000; Stacey and Fellowes, 2002). Besides, Athar *et al*. (2011) had additionally reported that the nutrient level on vegetables was one of the factors affecting the quantity of insects.

The results from this study show diversity in the number of insect species associated with cultivated amaranths at Bakajeba. There are diverse insect pests attacking amaranths causing considerable damage to yield of both leaves and grain (Robert *et al.,* 2015; Eke *et al.,* 2015). Hence, requiring control measures. These results concur with the investigation from similar survey carried out in Puebla, Mexico (López *et al.,*

2011). From the results, Heteroptera is the order with greatest number of species, that is, 13 species, which causes considerable damage to grains. The most significant genera in this genus was *Cletus* with four species. This genus was the most occurring with infestations of 80%. These insects are observed mostly at the beginning of milking stage and the population increases as the grain matures. This was also observed by Oke and Ofuya (2011) in their study on amaranths in Ibadan, Nigeria. They observed that the population of *Cletus* spp. increases gradually from the start of milking stage to maturity, with the highest population being recorded slightly before harvesting.

Among the insect pests encountered during the present study, thrips were found occupying and living within flowers of pepper presenting an uncommon scenario at the study region and proving difficult to control with reference to the flower part they occupied. Thrips are the number one pest of vegetables crops in tropical, subtropical and temperate climates. This is primarily is due to their polyphagous diet status and their ability to rapidly develop resistance to insecticides. The three most damaging species are the western flower thrips (WFT), *Frankliniella occidentalis* (Pergande), *Thrips tabaci* Lindeman and *Thrips palmi* Karny. *F. occidentalis* and *T. tabaci* are now cosmopolitan pests, these species feeds on a wide variety of crops but are especially problematic on *Capsicum* spp. Thrips generally prefer closed areas such as the flowers, under the calyx of fruit and in newly opening leaves (Ekenma *et al.,* 2017), which makes them difficult to reach with insecticides. Thrips have piercing-sucking mouthparts; epidermal and parenchymal cells are punctured, and the contents of the cells sucked out, resulting in silvery spots. Damage is caused by thrips feeding and ovipositing on pepper leaves, fruit and flowers.

Aphids and whites flies both have piercing and sucking mouthparts used to suck the sap out of eggplant leaves and stems. Both pests are found on the underside of the leaves of the plant. As they feed, they secrete a sticky substance known as honeydew, which reduces the plant's ability to photosynthesis. The silverleaf whitefly (*Bemisia argentifolii*) is the predominant species of whitefly that affects eggplant, and the green peach aphid (*Myzus persicea*) is the predominant aphid species.

ACKNOWLEDGEMENT

The authors express sincere thanks to Mr. Mathew Chori for his innumerable contributions to this research. Also for his time and efforts devoted for the identification of the insect pests recovered during the course of the study. I also thanked all the farmers whose farms were used for the research.

REFERENCES

Addo-Bediako, A.,Chown, S. L. and Gaston, K. J. (2000). Thermal tolerance, climatic variability and latitude. *In: Proceedings of the Royal Society B: Biological Sciences*. DOI: 10.1098/rspb.2000.1065 · Source: PubMed.

Athar, H. R., Bhatti, A., Bashir, N., Zafar Ullah Zafar, Z. U., Abida, and Farooq. A. (2011). Modulating infestation rate of white fly (Bemicia tabaci) on okra (Hibiscus esculentus L.) by nitrogen application. Acta Physiol Plant (2011) 33:843–850. DOI 10.1007/s11738-010-0609-4

Bosch, C. H., D. J. Borus and J. Siemonsma (2009). Vegetables of Tropical Africa. Conclusions and Recommendations based on PROTA 2: 'Vegetables'. Wageningen: PROTA Foundation.

Danks, C. and Barker, I. (2000). On-site detection of plant pathogens using lateral-flow devices. Paper presented at the EPPO Conference on diagnostic techniques for plant pests, Wageningen (NL), 2000-02-01/04. https://doi.org/10.1111/j.1365-2338.2000.tb00922.x

Ekenma, J. Agwu, G. E. O., Felicia E., Gerald, N. A., Michael, U. and Chukwuemeka, E. (2017). A survey of the insect pests and farmers' practices in the cropping of yellow pepper *Capsicum annuum* Linnaeus in Enugu State of Eastern Nigeria**,** *African Journal of Agricultural Research*. Vol. 13(15), pp. 742-752. DOI: 10.5897/AJAR2016.11834

Ezeh, A. E., Ogedegbe, A. B. O. and Ogedegbe, S. A. (2015). Insect Pest occurrence on Cultivated Amaranthus Spp in Benin City, Edo State, Nigeria, *Journal of Applied Science and Environmental Management*. Vol. 19 (2) 335 – 339. **DOI:** 10.4314/jasem.v19i2.22

Gilbert, N. and Raworth, D. A. (2000). Insect and Temperature-Differential effects of Experimental Conditions on Growth and Development. *The Canadian Entomologists*. Vol 132, issue 4. pp. 539-549.

IBBU. (2020). Department of Geography, Faculty of Applied Sciences, Ibrahim Badamasi Babangida University, Weather Stateion, Lapai, Niger State, Nigeria.

Khan, M. J., Drochner, W., Steingass, H. and Islam, K. M. S., (2008). Nutritive evaluation of some tree leaves from Bangladesh for feeding ruminant animals. *Indian Journal of*

Animal Science. 78 (11): 1273-1277.

Lopez, A. D., Tar, K., Krügel, U,, Dange, T., Ros, I. G. and Schmidt, M. (2011).. Proteasomal degradation of Sfp1 contributes to the repression of ribosome biogenesis during starvation and is mediated by the proteasome activator Blm10. *Molecular Biollogy of Cell*. 1;22(5):528-40. doi: 10.1091/mbc.E10-04-0352. PMID: 21209318; PMCID: PMC3046052

Losenge, T. (2005). Insect pest management for plant health: Population dynamics of Thrips in pure and mixed cropping. *Proceedings of 5th Horticultural Seminar on Sustainable Horticultural production in the Tropics* (p. 35). Njoro, Kenya: Horticultural Association of Kenya.

Maundu, P.M., Ngugi, G.W. and Kabuye, C.H.S. (1999) Traditional Food Plants of Kenya. Ed. Kenya Ressource Centre for indigenous Knowledge (KENRIK), National Muséum of Kenya, 270.

Mbugua, G., Gitonga, L. N., Mureithi, E., Karoga J. and Manyeki L. (2005). Farmer-Participatory prioritization and development of agronomic practices for African Leafy Vegetables. *Proceedings of 6th Horticultural Seminar on Sustainable Horticultural production in the Tropics* (pp. 152-166). Njoro, Kenya: Horticultural Association of Kenya.

Oke, A. and Ofuya, T. (2011). Relationship Between Population of Cletus fuscescens (Walker) (Hemiptera: Coreidae), Planting Dates, Lines and Grain Amaranth (Amaranthus spp.) Phenology. *Journal of Entomology*. 8(6):566-573. 10.3923/je.2011.566.573

Ouma, M. A. (2004). Indigenous Vegetable production and utilization in Suba district, Kenya: Improving health, unlocking the wealth in Suba district. *Biological Vision - T.T.U, ICIPE*.

Robert, N. K., Esther, N. K., Zipporah, O., Shadrack, M. and Catherine, W. (2013). Insect Abundance and Diversity on Cultivated *Amaranthus Spp.* (Amaranthacea) in Meru County, Kenya, American International Journal of Contemporary Research. *International Journal of Biology and Chemical Sciences.* 4(2): 400-406.

Sedaratian, A., Fathipour, Y., Talebi1, A. A. and Farahani, S. (2010). Population Density and Spatial Distribution Pattern of Thrips tabaci (Thysanoptera: Thripidae) on Different Soybean Varieties. *Journal of Agricultural Science and Technology*. Vol. 12: 275-288

Sithanantham, S., C. M. Matoka, M. Maundu, M. Jakari and S. G.

Agomg (2004). Integrated crop protection research for sustainable production of Indigenous vegetable crops in Eastern Africa. *Proceedings of 4th Horticultural Seminar on Sustainable Horticultural production in the Tropics* (pp. 152-166). Njoro, Kenya: Horticultural Association of Kenya.

Stacey, D. A. and Fellowes, M. D. E. (2002). Influence of elevated CO_2 on interspecific interactions at higher trophic levels. *Global Change Biology*. Vol. 8, issue 7, pp. 668-678. https://doi.org/10.1046/j.1365-2486.2002.00506.x

Subramanyam, B. and Hagstrum, D. (1995). Resistance measurement and management. In: Subramanyam B, Hagstrum D (Eds). Integrated management of insects in stored products. Marcel Dekker Inc. New York, pp. 331-398.

Faculty of Agriculture, Ibrahim BadamasiBabangida University, Lapai 2022
Lapai International Journal of Agriculture Vol. 3(1) June,2022 pp 670-682
ISSN:2705-2869

UTILIZATION OF CASSAVA PEEL MEAL AS SUBSTITUTE FOR MAIZE ON GROWTH INDICES AND CARCASS TRAITS OF BROILER CHICKENS

Ibrahim. H ., and Aliyu, Z.

Department of Animal Production, Faculty of Agriculture, Ibrahim Badamasi Babangida University, Lapai, Niger State, Nigeria.

ihadiza080@gmail.com zahradeen55@gmail.com ***08036101761***.

ABSTRACT

A feeding trial was conducted to determine the effect of substituting maize for cassava peel meal (CPM) on the growth indices and carcass characteristics of broiler chickens over 8 weeks study period dietary maize was replaced by cassava peel meal at 0 %(treatment 1) which serve as control. Treatment 2, 3, 4, and 5 contained 25, 50, 75 and 100% dietary maize replacement by cassava peel meal respectively for starter and finisher diets. Two hundred (200) day-old broiler chicks were allotted into the five (5) dietary of four (4) replicates each in a completely randomized design (CRD). Feed and water were offered ad libitum. Data generation, growth indices parameters were collected over a period of eight (8) weeks using a Camry digital weighing scale for weekly weighing of the animals. Feed intake was determined on daily basis by finding the difference between the feed served to the animal and left over quantities. The difference in weight between the two gave the quantity of feed consumed per day. Mean daily weight gain and feed conversion ratio were also determined. Three birds per replicate were sacrificed and defeathered using hot water, after which the viscerals and cut-up parts were weighed, dressed weight and dressed percentage was recorded as well. The data obtained from the organs and parts were converted to percentage live weight and carcass weight respectively. Result obtained revealed significant ($p<0.05$) differences in the final weight, body weight gain, feed intake and feed conversion ratio. The result showed that birds fed 0% cassava peel meal had the highest weight gain of 1497.48g, which was followed by those fed, 75%(1200.70g) 50%(1099.18g) and 25%(1008.23g) cassava peel meal respectively, while birds on 100% cassava peel meal had the least weight gain of 454.20g. Results of carcass characteristics of broiler chicken fed with different dietary level of cassava peel meal as substitute for maize showed that significant ($p<0.05$) differences were observed in the dressing weight, dressed percentage, and head. There were no significant ($p>0.05$) differences in the value of neck, back, breast muscle, wing, thigh, shank and drum stick. The study showed that cassava peel meal could replace at 75% dietary maize in the diets of broiler chicken without having any adverse effect on the growth performance and carcass characteristics of the broiler birds

KEYWORDS: Broilers, substitute, cassava peel, Growth performance, Carcass parameters

Faculty of Agriculture, Ibrahim BadamasiBabangida University, Lapai 2022
Lapai International Journal of Agriculture Vol. 3(1) June,2022 pp 670-682
ISSN:2705-2869

INTRODUCTION

Broiler birds are those kept and reared for meat production from day-old to about eight weeks of age for good quality tender meat as source of protein in human diet. However, the profit levels in poultry enterprises have been constrained by a number of factors critical among which is feed quality and cost. Feed is the major component of input cost accounting for up to 70% (The Poultry Site, 2007) and 86-87% (Hassan *et al.,* 2006) of the total variable cost of production. The high feed cost has largely been attributed to competition between man and animals for limited grains. The seasonality and cost of conventional feedstuffs are such that some degree of supplementary feeding and alternative energy source is required. (Salami and Odunsi 2003). Poultry production has been limited by scarcity of grains in Nigeria. There is need therefore to exploit cheaper energy sources to replace the expensive cereal for monogastric animal feeding. Therefore, there is need to exploit the use of potential feedstuff and agro industrial by-products such as cassava peels that are abundant in Nigeria for inclusion in the diet of poultry. Cassava is a major staple food in the developing world, providing a basic diet for over half a billion people (Fauquet and Fargette, 1990). The peel accounts for 10- 13 percent of the tuber by weight. Cassava peel is a major by-product of cassava tuber roots processing industry. It is the outer cover of the tuber root which is usually removed manually with sharp knife (IITA, 1990). These peels are regarded as waste and are usually discarded and allow to rot. The future utilization of cassava peels depends very much upon the development of improved processing technologies and improved products that can meet the changing needs of poultry farmers and on its suitability for alternative uses as animal feeds. Hahn (1988) reported that about 4 – 6 tons of cassava peel meal is produced in the country annually. Cassava peel constitutes 11-12% of total cassava root. Its chemical and proximate composition reveals high gross energy value of (3810kcal/kg ME), low protein (4.0%), digestible fat (0.9%), crude fiber (4.7%), ash (1.9%), and nitrogen free extract (88.5%) that could be efficiently utilized by poultry (Obioha, 1992). However, the cassava peel meal contains high levels of hydrocyanide and high fiber which is the most limiting factors restricting its use in the diets of poultry. On the other hand, adequate processing methods such as sun drying and inclusion of additives such as methionine, cysteine and Roxazyme-G enzyme in the diets have been reported to enhance its utilization (Bashar, 1997; Ohiaege, 1999; Ojo and Deane, 2002). The use of cassava by-products as feedstuffs or as an alternative substrate for biotechnological processes is a positive way to reduce prices of energy sources for livestock feed (Pandey *et al.,* 2000). This work was therefore designed to investigate a cheaper feed material that will lower the cost of feed for the feed industry, maximizing the profit for farmers and making poultry products cheaper to

consumers.

MATERIALS AND METHODS

Study area

The research was carried out at the Teaching and Research Farm of Ibrahim Badamasi Babangida University, Lapai, Niger state, Nigeria.

Source and processing of ingredients

Cassava peel was obtained from Gwada market in Shiroro local government area of Niger state. Maize, wheat offal, groundnut cake, fishmeal, bone meal salt, vitamin premix, methionine and lysine and were purchased from shop 29, Gidan Matasa Minna, Niger state.

The cassava peel was sun-dried for 10 days and spread in an open room with good air circulation for 20 days before milling to produce cassava peel meal. The sundried cassava peel was grounded using a hammer mill.

Experimental diets

Five experimental diets were formulated. The diets contained graded levels of processed cassava peel meal (CPM) that replaced maize at 0, 25, 50, 75 and 100% respectively. Diets 2-5 contained graded levels of processed cassava peel meal. Diet 1 have zero (0%) replacement and served as the control

Table 1: Gross composition of experimental broiler starter diet

Ingredients (%)	T1	T2	T3	T4	T5
Cassava peal meal	0.00	12.00	24.00	36.00	48.00
Maize	48.00	36.00	24.00	12.00	0.00
Wheat offal	13.00	13.00	13.00	13.00	13.00
Fish meal	3.00	3.00	3.00	3.00	3.00
Groundnut cake	31.70	31.70	31.70	31.70	31.70
Bone meal	2.50	2.50	2.50	2.50	2.50
Lime stone	1.00	1.00	1.00	1.00	1.00
Methionine	0.20	0.20	0.20	0.20	0.20
Lysine	0.10	0.10	0.10	0.10	0.10
Vitamin premix	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00
Calculated values					
Crude protein (%)	23.23	23.01	23.24	22.85	22.64
Crude fiber(%)	4.16	4.40	4.64	4.88	5.12
Metabolizable energy (kcal/kg)	2814.01	2804.97	2813.32	2801.32	2808.22

T1: zero (0%) inclusion of cassava peal meal
T2: Twenty-five (25%) inclusion of cassava peal meal
T3: Fifty (50%) inclusion of cassava peal meal
T4: Seventy-five (75%) inclusion of cassava peal meal
T5: One hundred (100%) inclusion of cassavaeal meal

Table 2: Gross composition of experimental broiler finisher diets

Ingredients (%)	T1	T2	T3	T4	T5
Cassava peal meal	0.00	13.50	27.00	40.50	54.00
Maize	54.00	40.50	27.00	13.50	0.00
Wheat offal	15.00	15.00	15.60	15.60	15.00
Fish meal	2.00	2.00	2.00	2.00	2.00
Groundnut cake	24.70	24.70	24.70	24.70	24.70
Bone meal	2.50	2.50	2.50	2.50	2.50
Lime stone	1.00	1.00	1.00	1.00	1.00
Methionine	0.20	0.20	0.20	0.20	0.20
Lysine	0.10	0.10	0.10	0.10	0.10
Vitamin premix	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00
Calculated values					
Crude protein (%)	20.15	20.20	20.27	19.80	19.78
Crude fiber(%)	4.15	4.42	4.69	4.96	5.23
Metabolizable energy (kcal/kg)	2836.88	2810.94	2800.15	2802.16	2802.19

T1: zero (0%) inclusion of cassava peal meal
T2: Twenty-five (25%) inclusion of cassava peal meal
T3: Fifty (50%) inclusion of cassava peal meal
T4: Seventy-five (75%) inclusion of cassava peal meal
T5: One hundred (100%) inclusion of cassava peal meal

Experimental birds and management

Two hundred (200) day-old broiler chicks were purchased from Amo hatchery and used for the experiment. The birds were allotted into five (5) dietary treatments with four (4) replicates each in a completely randomized design (CRD). The birds were weighed on arrival to get initial body weight and subsequently on weekly basis to get the body weight gain. On arrival, anti-stress drug (Vitalyte) was added to their drinking water. Adequate feed and water were provided for the chicks during brooding. Routine vaccination schedule were properly observed and the health status of the birds were well taken care.

Experimental layout.

Two hundred (200) broiler chicks were allotted to five dietary treatments (T1, T2, T3, T4, and T5). Each treatment consists of 40 broiler chicks with four replicates of 10 chicks each.

Treatments

Replicates	T1	T2	T3	T4	T5
R1	T1R1	T2R1	T3R1	T4R1	T5R1
R2	T1R2	T2R2	T3R2	T4R2	T5R2
R3	T1R3	T2R3	T3R3	T4R3	T5R3
R4	T1R4	T2R4	T3R4	T4R4	T5R4

Data collection

Performance parameters

Data collection parameters were collected over a period of eight (8) weeks using a Camry digital weighing scale for weekly weighing of the animals. Feed intake was determined on daily basis by finding the difference between the feed served to the animal and left over quantities. The difference in weight between the two gave the quantity of feed consumed per day. Mean daily weight gain and feed conversion ratio were also determined. Below are the formulas for calculating growth parameters

Feed intake = feed offered (g) - left over (g).

Weight gain = final weight (g) - initial weight (g).

$$\textbf{Feed conversion ratio (FCR)} = \frac{\text{feed consumed(g)}}{\text{weight gain (g)}}$$

$$\textbf{Mean daily gain} = \frac{\text{mean final weight gain}}{\text{number of days}}$$

$$\textbf{Mean feed intake} = \frac{\text{feed intake}}{\text{number of days}}$$

$$\textbf{Mortality (\%)} = \frac{\text{number of dead birds}}{\text{initial number of the birds}} \times 100$$

Carcass characteristics

Three birds per replicate were slaughtered and defeathered using hot water, after which the viscerals and cut-up parts were weighed, dressed weight and dressed percentage was recorded as well. The data obtained from the organs and parts were converted to percentage live weight and carcass weight respectively.

That is: $\frac{\text{cut} - \text{up parts}}{\text{carcass weight}} \times 100$

$$\frac{\text{visceral parts}}{\text{live weight}} \times 100$$

Statistical analyses

Data collected were subjected to analysis of variance (ANOVA) according to the procedure of Steel and Torrie (1980) and significant means were separated using Duncan Multiple Range Test (Duncan, 1955).

RESULTS

Performance characteristics of broiler chickens fed different dietary levels of cassava peel meal as substitute for maize.

Performance of finished broiler chickens is presented in Table 4.1. The final weight gain of the birds in treatment 1 had the highest average value of 1526.00kg while birds in treatment 5 were with lowest of 484.25kg weight. Also, the birds in Treatment 1 has the highest body weight gain (1497.48) followed by those birds in treatment 4 (1200.70), treatment 3 (1099.18), treatment 2 (1008.23), and the least were those birds in treatment 5 (454.20) respectively. There was significant ($P < 0.05$) difference in feed intake. However, feed intake decreased as the levels of cassava peal inclusion in the diets increased. Feed conversion ratios of the various dietary treatments were as follows, 1.94, 2.48, 2.22, 1.98, and 3.42 with birds in treatments 1-5 respectively.

Table 3: Growth performance of broiler chickens fed different dietary level of cassava peel meal as substitute for maize.

Parameters	T1	T2	T3	T4	T5	SEM	LSD
IWG(g)	28.53	30.03	30.05	30.05	30.05	1.15	0.59
FWG(g)	1526.00^{a}	1038.25^{ab}	1129.25^{a}	1230.75^{a}	484.25^{b}	272.19	0.02
BWG(g)	1497.48^{a}	1008.23^{ab}	1099.18^{a}	1200.70^{a}	454.20^{b}	271.82	0.02
DBWG(g)	26.74^{a}	18.00^{ab}	19.63^{a}	21.44^{a}	8.11^{b}	4.85	0.02
FI(g)	2898.50^{a}	2504.75^{b}	2436.25^{b}	2380.25^{b}	1552.50^{c}	180.43	0.00
DFI(g)	51.76^{a}	44.73^{b}	43.50^{b}	42.51^{b}	27.72^{c}	3.22	0.00
FCR(g)	1.94^{a}	2.48^{a}	2.22^{a}	1.98^{a}	3.42^{b}	0.37	0.01
Mortality (%)	0	2.50	2.50	5.00	7.50		

Means with no superscripts on the same row does not differ significantly (P>0.05), a, b: means with different superscripts on the same row differ significantly (P<0.05). IWG= initial body weight FWG= final bodyweight BWG= body weight gain, DBWG = daily body weight gain, FI= feed intake, DFI = daily feed intake, FCR = feed conversion ratio SEM = Standard Error of Means, LSD = Least of significance different.

Carcass characteristics of broiler chickens different dietary level of cassava peel meal as substitute for maize.

The cut-up parts of broiler chicken fed the different dietary level of cassava peel meal as substitute for maize is presented in Table 4.2. Significant (p<0.05) differences were observed in the dressing weight, dressed percentage, and the head. Highest value of dressing weight (938.50g) was recorded in treatment one while least value (464.24g) was recorded in treatment five. Treatment three had the highest value of (79.87%) dressing percentage while lowest value of (65.58%) was recorded in treatment four. There were no significant (p>0.05) differences in the value of neck, back, breast, wing, thigh, shank and drum stick. The highest weights of the wings and thigh were recorded in treatment three (13.61), (11.11) respectively, the highest weight for head, neck, and back were recorded on treatment five (5.44), (5.30), (10.56) respectively, highest weight for drum stick and shank were on treatment one (16.64), (4.79) accordingly and the highest weight for breast was on treatment two (10.31).

as substitute for maize.

Parameters	T1	T2	T3	T4	T5	SEM	LSD
Dressed wt. (kg)	938.50[a]	888.25[a]	883.25[a]	806.75[a]	464.25[b]	68.09	0.00
Dressing (%)	72.98[ab]	86.00[ab]	79.87[ab]	65.58[a]	96.08[b]	11.73	0.15
Head(g)	3.75[a]	3.60[a]	3.10[a]	2.97[a]	5.44[b]	0.76	0.04
Neck(g)	4.59	4.89	4.33	3.50	5.30	0.89	0.37
Wing(g)	11.42	13.22	13.61	9.05	13.06	2.31	0.30
Drumstick(g)	16.64	8.90	8.11	6.95	9.40	4.46	0.57
Thigh(g)	10.77	12.33	11.11	8.64	10.93	1.91	0.45
Shank(g)	4.79	4.25	3.99	3.22	4.43	0.95	0.26
Breast (g)	8.74	10.31	8.86	8.49	10.13	1.55	0.67
Back(g)	9.08	10.54	9.36	7.72	10.56	1.62	0.41

Means with no superscripts on the same row does not differ significantly (P>0.05), a, b: means with different superscripts on the same row differ significantly (P<0.05). SEM = Standard Error of Means, LSD = Level of significance different.

Table 5. Shows the per cent weights of heart, proventiculus, intestine, spleen, liver, gizzard, and abdominal fat differed significantly (p<0.05) across the dietary treatment levels. There were no significant (p>0.05) in the percentage weigh of lung and kidney, however higher percentages of (0.63%) and (0.73%) of lung and kidney were recorded in treatment two and five respectively. Highest percentage weigh of gizzard (4.70%), intestine (8.78%), pancreas (0.26%) where recorded in treatment five and two respectively.

Table 5: Visceral organs of broiler chickens fed different dietary level of cassava peel meal as substitute for maize.

Parameters	T1	T2	T3	T4	T5	SEM	LSD
Heart (g)	0.48^{a}	0.56^{a}	0.50^{a}	0.50^{a}	0.83^{b}	0.93	0.01
Pancrease(g)	0.25	0.26	0.11	0.07	0.12	0.11	0.34
Lung(g)	0.43	0.63	0.48	0.43	0.63	0.11	0.16
Spleen(g)	0.15^{a}	0.05^{b}	0.04^{b}	0.04^{b}	0.08^{ab}	0.04	0.09
Proventriculus(g)	1.59^{a}	1.75^{a}	1.20^{a}	0.98^{a}	2.93^{b}	0.36	0.00
Gizzard(g)	3.06^{a}	3.00^{a}	2.85^{a}	2.65^{a}	4.70^{b}	0.61	0.03
Liver(g)	1.65^{ab}	1.60^{ab}	1.70^{ab}	1.43^{a}	2.48b	0.39	0.12
Kidney(g)	0.53	0.70	0.61	0.53	0.73	0.13	0.39
Abdominal fat (g)	1.12^{ab}	1.48a	1.18^{ab}	0.93^{ab}	0.43^{b}	0.34	0.08
Intestine(g)	5.18^{ab}	7.48^{b}	5.45^{ab}	4.35^{a}	8.78^{bc}	1.26	0.02

Means with no superscripts on the same row does not differ significantly (P>0.05), a, b: means with different superscripts on the same row differ significantly (P<0.05). SEM = Standard Error of Means, LSD = Level of significance difference, T_1=treatment one (maize 100:0cassava peel meal),

DISCUSSION

The results of the study showed that birds fed 0% cassava peel had the highest weight gain of 1497.48g, which was similar to those fed 25%(1008.23g), 50%(1099.18g) and 75%(1200.70g) cassava peel respectively while birds on 100% dietary maize replaced by cassava peel had the least weight gain of 454.20g. This finding is in agreement with the report of Oyebimpe *et al* (2006), who reported that 200g/kg sun dried cassava peel could replace maize in broiler diets with no adverse reduction in their growth performance.

There was significant ($P < 0.05$) difference in feed intake. However, feed intake decreased as the level of cassava peal inclusion in the diets increased. This could be as a result of the dustiness of the cassava peel meal. Broilers birds are known to eat more when the diets are palatable and coarse than when finely ground and unpalatable (Lesson, 2000). This result is in line with the findings of Apata and Babalola (2012) who reported that dried cassava meal is floury in nature and this can reduce feed intake thereby reducing weight gain. Dustiness of cassava meal can cause irritation of the respiratory tract unless the feed is pelletized. Feed conversion ratios of the various dietary treatments are as follows, 1.94, 2.48, 2.22, 1.98, and 3.42 in treatment 1-5 respectively.

Treatment one with 0% substitute of cassava peel for maize had a better feed conversion ratio although statistically similar to those on diets 2, 3 and 4 while birds on treatment had the poorest feed conversion ratio across the treatments level which significantly differs ($p<0.05$) from the other treatments. This could be due to high level of crude fibre content of the diet which might have reduced the digestibility of the nutrients. Oyebimbe *et al.,* (2006) reported that high fiber diets usually tend to inhibit protein utilization at high inclusion levels, leading to low feed conversion ratio and body weight gain.

Highest value of dressing weight (938.50g) was recorded in treatment one while least value (464.24g) was recorded in treatment five. Treatment three had the highest value of (79.87%) dressing percentage while lowest value of (65.58%) was recorded in treatment four.

There were no significant ($p>0.05$) differences in the percentage weigh of lung and kidney, however higher percentages of (0.63%) and (0.73%) of lung and kidney were recorded in treatments two and five respectively. Highest percentage weigh of gizzard (4.70%), intestine (8.78%), pancreas (0.26%) where recorded in treatment five and two respectively. This could be supported with the findings of Borin *et al..,* (2006) who reported that the weight of pancrease, gizzard, and intestine increase with increased cassava peel meal. Hetland *et al.,* (2003) reported that insoluble fiber modulates gut development, digestive function and gizzard activity.

Conclusion

The results obtained from the study indicates that broilers could be raised on cassava peel meal at replacement level of 75% without having any statistical adverse effect on the growth performance and carcass characteristics of the broiler birds.

REFERENCES

.

Apata, D. F and Babalola, T. O. (2012). The use of cassava, sweet potato and cocoyam, and their by- products by non- ruminants. *International Journal of Food Science and Nutrition Engineering*.2(4): 54-62 55

Bashar, A. Y. (1997). Effect of roxazyme G enzyme supplementation of diets containing 50% and 100% cassava peel levels on the performance of finisher broilers. MSc dissertation, Department of Animal Science, University of Ibadan, Oyo, Nigeria. Pp 60-80.

Borin, K., LinSdberg, J.E and Ogie, R.B. (2006). Digestibility and digestive organ development indigenous and improved chickens and ducks fed diets with increasing inclusion levels of cassava leaf meal. *Journal of Animal Physiology*, 90(5-6): 230-237.

Duncan, D. B. (1955).New Duncans Multiple Range and Multiple F- test. *Biometrics* 11:1-42.

Fauquet, C. and Fargette, D. (1990) African cassava mosaic virus; Etiology, epidemiology and control. Plant disease 74: 404 - 411.

Fatufe, A.A, Akanbi, I.O, Saba, G.A., Oluwofeso, O. and Tewe O.O. (2007) Growth performance and nutrient digestibility of growing pigs fed a mixture of palm kernel meal and cassava peel meal. *Livestock Research for Rural Development*;19(180):129- 136

Hahn, S.K. (1988). An overview of traditional utilization of cassava in Africa. In: Cassava as livestock feed in Africa, Proceedings of the IITA/ILCA/U.I.workshop on the potential utilization of cassava as livestock feed in Africa. Ibadan, Nigeria. Pp. 59-62.

Hassan, A. A., Nwanta J. A. and Mohammed, A. (2006). Profitability analysis of egg production in Kaduna State. Nigeria. *Veterinary Journal* **27** *(1): 8-16.*

Hetland, H.; Svihus, B.; Krogdahl, A. (2003). Effects of oat hulls and wood shavings on digestion in broilers and layers fed diets based on whole or ground wheat. Br. Poult. Sci., 44(2): 275-282

IITA (1990), International Institute of Tropical Agriculture. Cyanide in cassava.

Leeson, S., Caston, L. and summers, J. D. (1996). Broiler response to diet energy. *Poultry Science Journal*, 75: 529-535.

Leeson, S. and Summers, J. D. (2000). Nutrition of the chicken 4th edn,

Unversity books, Ontario Pp. 413.

Obioha, F. C. (1992). A guide to poultry production in the tropics 1st (ed.) Accra Publishers, Enugu, Nigeria. Pp. 121-122

Ohiaege, P.E. (1999). A proximal analysis on the analytical comparability of the laboratory methods of determination, extraction and assay of cyanide. *Journal of Science of Food and Agriculture.*

Ojo, O. and Deane, R. (2002). Effect of cassava processing methods on the anti- nutritional components and health status of children. *Journal of Science of Food and Agriculture.* 82 (3): 252-257.

Oyebimpe, K., Fanimo, A.O," Oduguwa, O.O and Biobaku, W.O. (2006). Response of broiler chickens to cassava peel and maize offal in cashew nut meal-based diets. *Archivos de Zootecnia* 55: 301-304

Pandey, A., Soccol, C. R., Nigam, P., Soccol, V. T., Vandenberghe, L. P. S. and Mohan, R. (2000). Biotechnological potential of agro-industrial residues.II:cassava bagasse. Bioresource Technol., 74 (1): 81-87

Salami, R.I. and A.A. Odunsi, (2003). Evaluation of processed cassava peel meals as substitute for maize. *Int. J. Poult Sci.,* 2: 112-116

Steel R.G.D.and Torrie, J.H. (1980). *Principles and Procedures of Statistics.* A Biometrical Approach (2nd edition) McGraw-Hill Book Co. New York.*Food and Agricultural Organization* Rome, Italy, 51: 120-135.

The Poultry Site (2007): *Economic Approach to broiler production.* http:www.thepoultrysite.com/-articles/849/economic-approach-to-broiler production. Accessed on May 23, 2011

.

Usman, B.A. (2013). Vulnerability and adaptation capability of the rural poor farmers to climate change effect in Kwara State, Nigeria. *Lapai Sociological Review*, **4**(1): 142 – 162.

Faculty of Agriculture, Ibrahim BadamasiBabangida University, Lapai 2022
Lapai International Journal of Agriculture Vol. 3(1) June,2022 pp 683-695
ISSN:2705-2869

EFFECTS OF BUTYLATED HYDROXYTOLUENE ON THE QUALITY OF PRESERVED *KULIKULI,* A NIGERIAN SNACK

James, S[1*]., Ndife, J[2]., Yakubu, C. M[1]., Akinsoji, L[1]., Baba, A. I[1]., Audu, Y[1]. and Maxwell, Y. M. O[1]

[1]Department of Food Science and Technology, Federal University of Technology, PMB 65, Minna, Niger State, Nigeria
[2]Department of Food Science and Technology, Michael Okpara University of Agriculture, Umudike, Nigeria

samaila.james@futminna.edu.ng, 08062514350

ABSTRACT
The effects of butylated hydroxytoluene (BHT), a synthetic antioxidant at different concentrations on the keeping quality of the groundnut snack (*kulikuli*) was studied. Groundnut seeds were sorted, roasted, dehulled, winnowed and milled into a paste. The paste (2000 g) was then spiced with onion (65.3 g), pepper (20.3 g) and salt (39.4 g). To the paste, 400 mL of distilled water was added and the mixture was properly kneaded and pressed manually for oil extraction. After oil extraction, the resultant cake was weighed and divided into five equal portions (400 g each). To each portion of the cake 100 ppm, 150 ppm, 200 ppm, 250 ppm and 300 ppm butylated hydroxytoluene were added and properly mixed representing samples A, B, C, D and E, respectively. The cake was shaped cylindrically of nearly uniform thickness (0.02 m) and deep fried until hard, crunchy and dry brown snack. After drying, the snacks were cooled and packaged in a plastic container and stored for seven weeks at room temperature until need for analysis. The quality indices studied were peroxide value, free fatty acid, saponification value and sensory attributes. The results of the study showed that there were decreased levels of peroxide value, free fatty acid and saponification values with increased level of butylated hydroxytoluene over the storage period. For sensory attributes, all the parameters measured were not significantly influenced by different levels of butylated hydroxytoluene. Therefore, synthetic antioxidant investigated can be used at higher concentrations 200, 250 and 300 ppm for deterioration free groundnut snack production.

Keywords: Groundnut, paste, free fatty acid, peroxide value, saponification.

INTRODUCTION

Groundnut based local snack, *kulikuli* is a common snack in West Africa countries such as Ghana, Togo, Nigeria among others. The snack is popular in Northern part of Nigeria and it production and processing are mainly carried out by women as a source of income (Desai *et al*., 1996; Emelike and Akus, 2018). The local snack is made from ground dry roasted groundnut (paste). Spices such as powdered pepper and other ingredients such as salt, sugar, onion are added to the paste and properly mixed together prior to frying. The paste is stripped of excess oil and the resulting cake is molded into different shapes. The oil extracted from the paste is then heated to fry the shaped cake until it solidifies, hard, crunchy and allowed to cool before packaging in nylon or plastic containers or glass container (Desai *et al*., 1996; Adebesin *et al*., 2001).

The local snack is a good source of protein, fat, crude fibre, minerals as well as some B-group vitamins (Aletor and Ojelabi, 2007; Oladimeji and Kolapo, 2008; James and Nwabueze, 2013). The high protein content of the snack makes it a suitable protein source for complementing carbohydrates foods such as *gari* and pap. Ground form of the snack is seasoned with spices and used in the production of local meat snack called 'kilishi'. Furthermore, the snack is commercially used as a protein source in formulating feed for livestock (Akano and Atanda, 1990).

Deep-fat-frying of the cake affects the quality of the oil as well as that of the fried snack. It leads to the hydrolysis of poly unsaturated fatty acids and destruction of vitamin E which is a natural anti-oxidant. Degradation of the oil makes it susceptible to lipid oxidation (Damame *et al*., 1990). This limits the shelf life and storage stability of both the oil and the fried snack. Furthermore, lipid oxidation reactions are accelerated by high temperature, presence light and oxygen exposure (Fontanella, 2015). The reactions in the snack lead to rancidity which shortens the shelf life and affects storage stability, texture and brings about off-flavour development and these affect the processing of the snack in commercial scale (Adebesin *et al*., 2001).

The development of rancidity in snacks can be eliminated by the use of food additives, especially anti-oxidants such as butylated hydroquinone (TBHQ), butylated hydroxytoluene (BHT), butylated hydroxyanisole (BHA) (Fontanella, 2015). The anti-oxidants aero usually added in low concentration (Halliwell and Gutteridge, 1995). Therefore, this study is designed to assess the effective dosage of butylated hydroxytoluene on the quality preservation of *kulikuli* snack.

MATERIALS AND METHODS

Experimental site

Preparation of sample, production of *kulikuli* and laborotary analysis of test samples were carried out in Food Science and Technology Laboratory, Federal University of Technology, Minna, Nigeria.

Sources of raw materials

Groundnut, onion, salt and pepper (powdered form) were gotten from Minna, Niger State and the anti-oxidant (butylated hydroxytoluene) from Cenral Research Laborotary, Tanke, Ilorin, Kwara State.

Production of groundnut snack

Groundnut was manually sorted to remove extraneous materials. Sorted groundnut was then roasted in the laboratory in electric roasting machine (Sarah's Techno, China) at 100°C for 10 min. and allowed to cool at room temperature for 30 min. Roasted groundnut was dehulled by working it in a mortar using pestle and the skin winnowed in the air. Winnowed dahls were milled in to a paste using an electric grinding machine. To 2.2 kg of the paste, 20.30 g of powdered pepper, 20.30 g salt and 65.3 g onion were added and thoroughly mixed using a laboratory blender (SP-BL16, China). Oil extraction was carried out via wet oil extraction method by adding 400 ml of distilled water, followed by stirring, kneading and pressing the mixture until oil was separated from the paste. After the oil extraction, the cake was then weighed (2000 g) and divided into 5 equal parts (400 g each). Butylated hydroxytoluene (BHT) (antioxidant) was added to each part in the following concentrations 100 ppm, 150 ppm, 200 ppm, 250 ppm and 300 ppm and properly mixed representing samples A, B, C, D and E, respectively. The cake was shaped cylindrically of nearly uniform thickness (0.02 m). Shaped cakes were then dip-fried in the oil at 130°C for 5 min to harden and make the snacks crunchy. Fried snacks were allowed to cool at room temperature (27 ± 0.2°C) for 10 min and packaged in high density polyethene sac and kept at room temperature for the duration (7 weeks) of the study.

Determination of Free Fatty Acid

To determine the concentration of free fatty acid in the samples, 25 ml of ethanol was measured and 25 ml of ether was added, then four drops of phenolphthalein were added to the solution. Potassium hydroxide (0.1 m) was then added to the solution in the beaker. This solution is called the neutral solvent. The *kulikuli* was pounded and 0.5 g was measured and put in a beaker, 25 ml of the neutral solvent was added to the weighed sample and mixed thoroughly. Two drops of phenolphthalein indicator were added then the solution was titrated against potassium hydroxide, while titrating, the colour turns pink and fades away. The titration continued until the pink colour did not fade away after shaking for fifteen seconds. Then the volume of potassium hydroxide used is recorded. This experiment was carried out at intervals of one week for one month. Free fatty acid was determined using the following equation (AOAC, 2005):

$$FFA = \frac{TV - m\,(KOH)0.1 \times 56.10}{w} \quad (1)$$

Where; FFA = free fatty acid; TV = titre value; M = molarity; W = weight

Determination of Peroxide Value

One gram (1 g) of the pounded sample was weighed and put in a conical flask then 25cm^3 of 2:1 v/v of glacial acetic acid and chloroform solvent were added. One (1) cm^3 of 10% of potassium iodide was added to the solution then the solution was allowed to stand in the dark for ten minutes. Thirty (30) cm^3 of distilled water was added then the solution was titrated against 0.02 m sodium thiosulphate using 1 cm^3 of 1% starch solution as indicator. A blank determination was carried out in the same way. The peroxide value was determined using the following equation (Onwuka, 2005):

$$pv = \frac{1000(v_1 - v_2) \times m}{w} \qquad (2)$$

Where; PV = peroxide value; V_1 = volume of the blank sample; V_2 = volume of the titer value; M = molarity; W = weight of sample.

Saponification Test

One gram (1 g) of each sample was poured into different conical flasks and 5 mL of ethanol was poured into each sample and then 25 mL of 0.5% potassium hydroxide was added to each sample; mixed thoroughly and kept in the heater for thirty minutes. After then samples were brought out to cool for 10 min then 1 mL of phenolphthalein was dropped into each conical flask as an indicator which turned the solution blackish. The solution was then titrated against 0.5% M hydrochloric acid solutions until it became faint. A blank solution was prepared in the same way. The volume of hydrochloric acid used was recorded. The saponification was determined using the following equation (Onwuka, 2005):

$$S = \frac{blank - tv \times m \times 56.10}{w} \qquad (3)$$

Where: S = saponification; TV = titration value; M = molarity; W = weight

Sensory attribute test

Sensory tests were conducted with 20 semi-trained panellists made up of a population of staff and students of Federal University of Technology, Minna who declared themselves as regular consumers of *kulikuli*. Samples were randomly coded and analyzed for texture and and overall acceptability, using a 9-point structured hedonic scale (1 = dislike extremely, 2 = dislike very much, 3 = dislike moderately, 4 = dislike slightly, 5 = neither like nor dislike, 6 = like slightly, 7 = like moderately, very much likeand 9 = like extremely) (da Silva Oliveira *et al*., 2022). Necessary precautions were taken to prevent carry-over flavour during the tasting by ensuring that panelists pass a piece of lemon fruit in their mouths or rinse with water after each stage of sensory evaluation.

Statistical analysis

Laboratory data (free fatty acid, peroxide value, saponification value and sensory attributes) were determined in triplicates and subjected to one-way analysis of variance and expressed as mean with standard deviation. The differences between means were separated by Duncan's Multiple Range Test using IBM SPSS Statistics Programme, Version 19.0 (Illinois, USA). Significant differences were expressed at 5% level.

RESULTS

Table 1: **Free fatty acid (mg/100 g) of groundnut snack treated with butylated hydroxyltoluene**

Week	A	B	C	D	E
1	3.97 ± 0.07^{a}	3.87 ± 0.07^{a}	3.43 ± 0.07^{b}	$3.41^{b}\pm0.07^{b}$	$3.30^{b}\pm0.07^{b}$
3	4.60 ± 0.07^{a}	4.50 ± 0.07^{a}	4.02 ± 0.07^{b}	$3.80^{b}\pm0.07^{b}$	$3.50^{b}\pm0.07^{b}$
5	5.08 ± 0.03^{a}	5.08 ± 0.03^{a}	4.50 ± 0.03^{b}	$4.02^{b}\pm0.03^{b}$	$3.97^{b}\pm0.03^{b}$
7	5.08 ± 0.07^{a}	5.08 ± 0.07^{a}	4.70 ± 0.07^{b}	$4.60^{b}\pm0.07^{b}$	$4.02^{b}\pm0.07^{b}$

Data are means ± standard error of duplicate determination.
Means with common superscripts in the row are not significantly different at $p \geq 0.05$.
Key A = Groundnut snack treated with 100 ppm of BHT; B = Groundnut snack treated with 150 ppm BHT; C = Groundnut snack treated with 200 ppm BHT; D = Groundnut snack treated with 250 ppm BHT; E = Groundnut snack treated with 300 ppm; BHT anti-oxidant; BHT = Butylated hydroxytoluene.

The free fatty acid values of the snack samples stored over seven weeks of storage are shown in Table 1. The results revealed that different concentrations of BHT used in this study significantly ($p<0.05$) affected the free fatty acid values all through the study period. Their values ranged from 3.30 to 3.97 mg/100 g, 3.50 to 4.60 mg/100 g, 3.97 to 5.08 mg/100 g and 4.02 to 5.05 mg/100 g at the end of 1, 2, 3, 5 and 7 weeks of storage, respectively. In respective of the weeks of storage, higher concentrations of BHT used (200 ppm, 250 ppm and 300 ppm) significantly ($p<0.05$) gave low levels of free fatty acids in the snacks.

Table 2: **Peroxide value ($meqO_2$ /g) of groundnut snack stored over seven week period**

Week	A	B	C	D	E
1	9.35 ± 0.58^{a}	8.25 ± 0.48^{a}	8.00 ± 0.67^{ab}	7.00 ± 0.98^{b}	6.75 ± 0.38^{b}
3	10.40 ± 0.81^{a}	9.50 ± 0.71^{a}	8.35 ± 0.81^{ab}	7.50 ± 0.82^{b}	6.95 ± 0.79^{b}
5	3.50 ± 0.36^{a}	3.35 ± 0.36^{a}	2.30 ± 0.36^{ab}	1.60 ± 0.36^{b}	1.30 ± 0.36^{b}
7	3.50 ± 0.30^{a}	3.25 ± 0.29^{a}	2.00 ± 0.20^{ab}	1.30 ± 0.30^{b}	0.75 ± 0.31^{b}

Data are means ± standard error of duplicate determination.
Means with common superscripts in the row are not significantly different at $p \geq 0.05$.
Key A = Groundnut snack treated with 100 ppm of BHT; B = Groundnut snack treated with 150 ppm BHT; C = Groundnut snack treated with 200 ppm BHT; D = Groundnut snack treated with 250 ppm BHT; E = Groundnut snack treated with 300 ppm; BHT anti-oxidant; BHT = Butylated hydroxytoluene.

Table 2 showed the peroxide values of the snacks stored over seven weeks. Their values ranged from 6.75 to 9.35 $meqO_2$ /g, 6.95 to 10.40 $meqO_2$ /g, 1.30 to 3.50 $meqO_2$ /g and 0.75 to 3.50 $meqO_2$ /g at the end of 1, 3, 5 and 7 weeks of storage, respectively. Snacks with lower concentrations of BHT (samples A, B and C) had higher levels of peroxide values. However, snacks with higher concentrations of BHT that is samples D and E had significantly ($p<0.05$) lower peroxide values. It can be deduced that the higher the concentration of the synthetic antioxidant (BHT) used the lower the peroxide values.

Table 3: **Saponification value (mg KOH/g) of groundnut snack treated with butylated hydroxy toluene taken at two weeks interval**

Week	A	B	C	D	E
1	263.49 ±4.04^{a}	234.44±5.04^{b}	215.46±4.94^{c}	187.46±4.04^{d}	128.38±4.0^{e}
3	275.25±10.00^{a}	195.93±9.98^{b}	232.20±10.20^{b}	148.37±11.00^{c}	91.36±10.00^{e}
5	340.32±8.43^{a}	287.51±8.43^{b}	238.95±8.43^{c}	221.95±8.43^{c}	178.93±8.43^{d}
7	388.86±15.13^{a}	279.50±15.13^{b}	250.97±15.13^{b}	234.47±15.13^{bc}	190.95±15.13^{c}

Data are means ± standard error of duplicate determination.
Means with common superscripts in the row are not significantly different at $p \geq 0.05$.
Key A = Groundnut snack treated with 100 ppm of BHT; B = Groundnut snack treated with 150 ppm BHT; C = Groundnut snack treated with 200 ppm BHT; D = Groundnut snack treated with 250 ppm BHT; E = Groundnut snack treated with 300 ppm; BHT anti-oxidant; BHT = Butylated hydroxytoluene.

The saponification values of the snacks preserved with different concentrations of BHT and stored over seven weeks of storage is shown in Table 3. The results showed that different concentrations of BHT used significantly ($p<0.05$) influenced the saponification values of the snacks throughout the seven weeks of storage. Their values ranged from 128.38 to 263.49 mg KOH/g, 91.36 to 275.25 mg KOH/g, 178.93 to 340.32 mg KOH/g and 190.95 to 388.86 mg KOH/g at the end of 1, 3, 5 and 7 weeks of storage, respectively. There was decrease in the saponification values with increasing concentrations of BHT in the snacks. Sample E which had the highest concentration of BHT (300 ppm per 400 g of cake) was the lowest in saponification value throughout the seven weeks of storage. However, sample A which contained the lowest concentration of BHT (100 ppm per 400 g of cake) had the highest saponification values throughout the study period.

Table 4: **Sensory score for texture from week one to week seven**

Week	A	B	C	D	E
1	8.07±0.00^a	8.17± 0.00^a	8.01±0.04^a	8.09±0.03^a	8.07±0.00^a
2	8.07±0.15^a	7.97±0.25^a	8.07±0.15^a	8.07±0.15^a	8.07±0.15^a
3	8.07±0.00^a	8.07±0.00^a	8.08±0.00^a	8.07±0.00^a	8.08±0.00^a
4	8.07±0.00^a	8.07±0.00^a	8.07±0.00^a	8.17±0.80^a	8.0 7±0.00^a
5	6.33±0.18^a	6.13±0.18^a	6.40±0.18^a	6.23±0.18^a	6.40±0.18^a
6	6.40±0.00^a	6.50±0.01^a	6.70±0.00^a	6.40±0.00^a	6.40±0.00^a
7	6.40±0.14^a	6.40±0.14^a	6.40±0.14^a	6.40±0.14^a	6.40±0.14^a

Data are means ± standard error of duplicate determination.
Means with common superscripts in the row are not significantly different at $p \geq 0.05$.
Key A = Groundnut snack treated with 100 ppm of BHT; B = Groundnut snack treated with 150 ppm BHT; C = Groundnut snack treated with 200 ppm BHT; D = Groundnut snack treated with 250 ppm BHT; E = Groundnut snack treated with 300 ppm; BHT anti-oxidant; BHT = Butylated hydroxytoluene.

Table 4 showed the texture scores of the snacks taken at one week interval over seven weeks of storage. The results revealed that different concentration of BHT did not significantly ($p>0.05$) affect the texture perception of the snacks by the taste panelist who are familiar with the product. Also, it can be deduced that snacks assessed and the end of 1, 2, 3 and 4 weeks had similar ratings, slightly above 8 points. However, as the storage period progressed, that is at the end of 5, 6 and 7 weeks of storage, the scores were rated low, slightly above 6 points.

Table 5: **Sensory score for general acceptability from week one to week seven**

Week	A	B	C	D	E
1	7.23±0.10^a	7.26± 0.00^a	7.30±0.00^a	7.03±0.00^a	7.33±0.00^a
2	7.93±0.13^a	7.93±0.13^a	7.93±0.13^a	7.93±0.13^a	7.93±0.13^a
3	7.83±0.10^a	7.93±0.00^a	7.90±0.10^a	7.93±0.00^a	7.93±0.00^a
4	7.93±0.00^a	7.90±0.10^a	7.93±0.00^a	7.92±0.01^a	7.93±0.00^a
5	6.53±0.20^a	6.53±0.20^a	6.53±0.20^a	6.53±0.20^a	6.53±0.20^a
6	6.53±0.15^a	6.63±0.25^a	6.53±0.15^a	6.77±0.25^a	6.77±0.25^a
7	6.07±0.15^a	6.06±0.13^a	6.07±0.15^a	6.07±0.15^a	6.05±0.13^a

Data are means ± standard error of duplicate determination.
Means with common superscripts in the row are not significantly different at $p \geq 0.05$.
Key A = Groundnut snack treated with 100 ppm of BHT; B = Groundnut snack treated with 150 ppm BHT; C = Groundnut snack treated with 200 ppm BHT; D = Groundnut snack treated with 250 ppm BHT; E = Groundnut snack treated with 300 ppm; BHT anti-oxidant; BHT = Butylated hydroxy toluene.

The general acceptability of the snacks rated at one week interval over seven weeks of storage is shown in Table 5. The results showed that different concentrations of BHT did not significantly ($p>0.05$) influence the general acceptability of the snack samples. The samples were scored above 7 points during the first four (4) weeks of storage. However, at weeks 5, 6 and 7 the samples were rated low, at 6 points range.

DISCUSSION

Generally speaking, antioxidants are chemical substances which slow down the autoxidation process of other compounds or stabilize free radicals. These chemical substances are used industrially in food processing to prevent lipid oxidation and for the retention of food sensory attributes (flavour, aroma and colour). Also, most pharmaceutical products contain them. Synthetic antioxidants including butylated hydroxytoluene (BHT) have been implicated as well as presumed to have adverse effects on the health of biological organisms. However, when used at safer dosage, they do not constitute any health threat.

The most important indices that allow for the estimation of oxidative stability of finished products are free fatty acids (FFAs) which determines the process of acidification of fatty component or the degree of hydrolytic rancidity; peroxide value (PV) which indicates the degree of primary oxidation and p-Anisidine value (AnV) which evaluates the formation of molecules (aldehydes and ketones) responsible for the organoleptic alterations

(Fontanella, 2015).

The results of the free fatty acids (Table 1) showed that different concentrations of BHT used in this study significantly ($p<0.05$) influenced the concentration of free fatty acids in the samples. At the end of first week of storage, the FFAs content ranged from 3.30 to 3.97 mg/g. Samples A and B which had lower doses of BHT (100 ppm and 150 ppm per 400 g of *kulikuli*) were significantly ($p<0.05$) higher in free fatty acid contents 3.97 mg/100 g and 3.87 mg/ 100 g, respectively. However, *kulikuli* samples with higher concentrations of BHT (200 ppm, 250 ppm and 300 ppm) showed significantly ($p<0.05$) lower FFAs contents 3.43 mg/100 g, 3.41 mg/100 g and 3.30 mg/100 g, respectively. The same trend was observed at the end of the third, fifth and seventh weeks of storage duration where lower doses of BHT (100 ppm and 150 ppm) used showed higher concentrations of FFAs whereas, higher doses (200 ppm, 250 ppm and 300 ppm) showed significantly ($p<0.05$) lower concentration of FFAs at the end of storage periods. Furthermore, higher concentrations of BHT used in this study which are within the safe permitted levels in food samples, have the capacity to limit the development of free fatty acids in the samples and their concentrations do not differ significantly ($p>0.05$).

The peroxide value is used to measure oxidative rancidity of fatty food product. The lower the peroxide value the better the oil content (Ihekoronye and Ngoddy, 1985). Also, it is used as an index of early stage of lipid oxidation. The result of this study (Table 2) showed that different concentrations of BHT used significantly ($p\leq 0.05$) affected the peroxide value of the samples. The peroxide value decreased as the concentration of BHT increases. At the end of first, third, fifth and seventh weeks of storage, the peroxide values ranged from 6.75 to 9.35 meqO_2/kg, 6.95 to 10.40 meqO_2/kg, 1.30 to 3.50 meqO_2/kg and 0.75 to 3.50 meqO_2/kg, respectively. *Kulikuli* snacks with lower concentrations of BHT that is samples A, B and C showed higher development of peroxide while, samples D and E which had higher concentrations of BHT 250 ppm and 300 ppm per 400 g of the sample recorded lower development of lipid peroxide throughout the storage period. Notably, there was marked increases in the peroxide contents among samples at the end of third week of storage, while at the end of the fifth and seventh weeks of storage, the value drastically reduced most especially at the end of seventh week of storage. The result obtained in this study agrees with the findings of Azuma *et al*. (1999) and Oladimeji *et al*. (2013) who reported that, anti-oxidative effect of BHT is dependent on it concentration. This result implies that, inclusion of BHT in the snack at 250 ppm and 300 ppm per 400 g has the efficacy to control lipid peroxidation of the product.

The saponification value indicates the size of fatty acid chain esterified to glycerol and gives the index of the average length of the fatty acid chain. The results (Table 3) showed that different concentrations of

BHT used in this study had significant ($p<0.05$) effect on the saponification value. There was significant ($p<0.05$) decrease in the saponification values with corresponding increase in the concentration of BHT. At the end of the first, third, fifth and seventh weeks of storage, the saponification values ranged from 128.38 to 263.49 mg KOH/g, 91.36 to 275.25 mg KOH/g, 178.93 to 340.32 mg KOH/g and 190.95 to 388.86 mg KOH/g, respectively. Sample A which had 100 ppm BHT per 400 g of sample and sample C which had 200 ppm BHT per 400 g of the sample, showed steady increase in the saponification values throughout the duration of storage. There was a shift in the trend, where samples B, D and E recorded a marked decrease in saponification at the end of the third week of storage but, at the end of the fifth and seventh weeks of storage, there were sharp increases with values above what was recorded at the end of the first week of storage. For reduced product saponification, higher concentrations of BHT (250 ppm and 300 ppm per 400 g of cake) appear the best.

The sensory attributes (Tables 4 and 5) in terms of texture and general acceptability of the *kulikuli* snacks taken weekly for seven weeks showed that, the samples were not significantly different from each other throughout the study period. This implies that, different levels of BHT and the storage time had no significant ($p>0.05$) influence on the texture and general acceptability of the snack.

CONCLUSION

Butylated hydroxytoulene used at different concentrations in this study showed significant variabilities in free fatty acid, peroxide and saponification values, as well as in the sensory attributes of the snacks over seven weeks storage time. For extended storage of *kulikuli* snacks, 250 ppm and 300 ppm of BHT per 400 g of cake showed significantly low levels of free fatty acid, peroxide and saponification values. Therefore, inclusion of BHT in the snack can be done at 250 ppm or 300 ppm per 400 g of the cake prior to frying and stored for 4 weeks.

ACKNOWLEDGEMENTS

The authors are sincerely grateful for the efforts of the Laboratory Technologists, Department of Food Science and Technology, Federal University of Technology, Minna, Nigeria.

REFERENCES

Adebesin, A. A., Saromi, O. T., Amsusa, N. A. and Fagade, S. O. (2001). Microbiological quality of some groundnut products hawked in Bauchi, a Nigerian City. *Journal of Food Technology in African,* 6(2): 53-55.

Akano, D. A. and Atanda, O. (1990). Present level of aflatoxin in Nigerian groundnut cake ('kulikuli'). *Letters in Applied Microbiology*, 10(4), 187-189.

Aletor, O., Ojelabi, A. (2007). Comparative evaluation of the nutritive and functional attributes of some traditional Nigerian snacks and oil seed cakes. *Pakistan Journal of Nutrition*, 6(1): 99–103.

AOAC (2005). Official Methods of Analysis of the Association of Analytical Chemist. International, 18th ed. U.S.A.

Azuma, K. K., Ippoush, I., Higasio, H. and Terao, J. (1999) "Evaluation of anti-oxidant activities of vegetable extract in linoleic acid emulsion and phospholipids bilayer, *Journal of Science, Food and Agriculture,* 79:1-7.

Damame, S. V., Chavan, J. K. and Toll, S. .S.(1990). "Effects of roasting and storage on protein and oil in peanut kernels". *Plant Foods and Human Nutrition*, 40: 143 – 148.

Desai, C. .J., Gindhart, J. G., Goldstein, L. S. B. and Zinn, K. (1996). Receptor tyrosine phosphatases are required for motor axon guidance in the Drosophila embryo. *Cell*, 84(4), 599-609.

da Silva Oliveira, E.C., da Luz, J.M.R. and de Castro, M.G. (2022). Chemical and sensory discrimination of coffee: impacts of the planting altitude and fermentation. European Food Research and Technology, 248: 659–669.

Emelike, N. J. T. and Akusu, M. O. (2018). Proximate Composition and Sensory Properties of "Kuli-Kuli" Produced from the Blends of Groundnut and Cashew Kernel. *International Journal of Food Science and Nutrition Engineering* 2018, 8(1): 1-4.

Fontanella, E. (2015). Shelf life: Informazioni pratiche per arrivare a definire la durabilità di un prodotto e a prolungare la sua vita commerciale. *Camera di Commercio di Torino*, (p. 50). Torino.

Halliwell, B., and Gutteridge, J. M. C. (1995). The definition and measurement of antioxidants in biological systems. *Free Radical and Biological Medicine,* 18 :125 - 126

Ihekoronye, A. I. and Ngoddy, P. O. (1985). Integrated Food Science and Technology for the Tropics. pp 364, Macmillan Publishers Ltd., London.

James S. and Nwabueze T. U. (2013).

Quality evaluation of extruded full fat blend of African breadfruit-soybean-corn snack. *International Journal of Scientific and Technology Research*, 2(9):212-216.

Oladimeji, G. R., Kolapo, A. L. (2008). Evaluation of proximate changes and microbiology of stored defatted residues of some selected Nigerian oil seeds. *African Journal of Agricultural Research,* 3(2): 126–129.

Oladimeji1, H. O., Ubulom, P. M. E. and Olugbade, T. A. (2013). Cytotoxicity studies on some Nigerian medicinal plants. *Advance Research in Pharmaceuticals and Biologicals*, 3(2):403-407.

Onwuka, G.I. (2005) Food analysis and instrumentation, theory and practice, Printed by Napthali Prints, A division of Hg support Nigerian Limited Surulere Lagos, Nigeria pp140-153.

Faculty of Agriculture, Ibrahim BadamasiBabangida University, Lapai 2022
Lapai International Journal of Agriculture Vol. 3(1) June,2022 pp 696-715
ISSN:2705-2869

COMPARATIVE EVALUATION OF DIFFERENT CATEGORIES OF COMMERCIAL TISANES (HERBAL TEAS) IN NIGERIA

James, S[1*]., Ndife, J[2]., Yakubu, C. M[1]., Akinsoji, L[1]., Baba, A. I[1]., Audu, Y[1]. & Maxwell, Y. M. O[1]

[1]Department of Food Science and Technology, Federal University of Technology, PMB 65, Minna, Niger State, Nigeria
[2]Department of Food Science and Technology, Michael Okpara University of Agriculture, Umudike, Nigeria

samaila.james@futminna.edu.ng, 08062514350

ABSTRACT

Recently the consumption of commercial herbal teas (tisanes) is on the increase among health-conscious consumers because of perceived medicinal benefits. Update information on their quality relative to the source plants is scarce. The powders and extracts of commercial tisanes from Moringa-leaves (MT), Cinnamon-bark (CT), Beet-root (BT) and Hibiscus-flower (HT) were analysed for their physicochemical, nutrient and antioxidant properties. Lipton tea brand (LT) served as control. There was significant ($p<0.05$) difference in the proximate contents of the tea powders. Moisture content of the tisanes ranged from 3.21% (cinnamon) to 4.7% (Hibiscus). The tisane powders had lower fat content (0.71 - 2.32%) than the control, lipton tea (2.65%). Beetroot tisane (MT) had the lowest ash (1.52%) followed by cinnamon tisane (2.34%). Calcium, sodium and potassium had higher values in MT and BT. The tisanes had high phytonutrient contents of flavonoid (2.54 - 4.78 mgQE/g), anthocyanin (1.73 - 2.24 mg/100 g) and tannins (1.43 - 2.34 mg/100 g) compared to LT. Tisane samples (0.55 - 0.98%) were more acidic than LT, (0.32%). The tea extracts were very low in carotenoid- pro-vitamin A (0.001 - 0.028 µg). The tea extracts had higher vitamin C (3.44 - 7.09 mg) than B-vitamins (0.01 - 2.20 mg/100g). The antioxidant power - 2,2-diphenyl-1-picrylhydrazyl (DPPH) (86.15 - 90.85%) and the ferric reducing antioxidant power (FRAP) (54.13 - 60.65 µmol) in herbal teas was significantly ($p<0.05$) higher when compared to LT of 73.77% and 51.22 µmol, respectively. The tisanes had better nutritive values, comparable physiochemical qualities and higher antioxidant properties than regularly consumed lipton tea.

KEYWORDS: Antioxidant, Extracts, Tea, Tisane, Powder

INTRODUCTION

Tea is consumed more than any other beverage worldwide (Ho *et al*., 2008). It is a hot water infusion of the dried leaves of the evergreen *Camellia sinensis* plant. In recent times, Tisane, a generic term for infusions or decoctions made from other plants (Juneja *et al*., 2013; Shannon *et al*., 2018), which serve as a beverage for their physiological or medicinal effects is gaining increasing popularity among health-conscious consumers because of their fragrance, antioxidant properties and therapeutic applications (Ravikumar, 2014; Ndife *et al*., 2019). Tisanes are mainly made from green and dried herbs, flowers, fruits, leaves, seeds, barks and roots of medicinal plants (Ravikumar, 2014). They have penetrated into an emerging niche market along with other popular beverages such as tea, coffee and cocoa (Chandrasekara and Shahidi, 2018). Unlike most other forms of tea, herbal teas taste great, are easy to drink and do not contain caffeine (Babarykin *et al*., 2019).

Tisanes are categorized by what part of the plant they come from: leaf tisanes (mint, neem, cocoa, lemon grass); flower tisanes (rose, chamomile, hibiscus and lavender); bark tisanes (cinnamon, slippery elm and black cherry bark); root tisanes (ginger, purple coneflower and chicory) and fruit tisane from citrus peel, raspberry, blueberry, peach (Ndife *et al*., 2019).

Cinnamon tea is highly nutritious. Its regular consumption could be beneficial to oxidative stress related illness in humans (Maheshwari *et al.,* 2013). Cinnamon tea offers helpful relaxation for stomach upset occasioned by the tension and strain of modern living. Consumption of cinnamon tea is also effective in decreasing the body weight which helps to reduce obesity and prevent obesity-related complications (Maheshwari *et al*., 2013).

Hibiscus sadariffa (L.) (commonly refers to as 'red sorrel' or 'roselle') tea is a popular sugary tisane that is quite common all over the world (Islam *et al*., 2016). The tea is an infusion made from crimson or deep magenta-coloured calyces (sepals) of the roselle flower. Aside being caffeine free, *H. sadariffa* tea is a rich source of nutrients like vitamins and minerals and also good source of antioxidants and anthocyanins which acts as free radical scavengers which inhibits lipid per-oxidation (Islam *et al*., 2016).

Moringa is commonly known as drumstick-tree, horseradish or miracle tree. It is also known with the following local names: “Zogallagandi” (Hausa), “Ewe-igbale” (Yoruba) and “Okwe Oyibo” (Igbo). Every part of *M. oleifera* is a storehouse of important nutrients (Okafor and Ogbobe, 2015). The leaves of *M. oleifera* are rich in minerals and phytochemicals such as sterols and terpenoids (Kasolo *et al*., 2010; Ilyas *et al*., 2015). Extracts from the leaves are used to treat malnutrition, augment breast milk in lactating mothers. It is used as potential antioxidant, anticancer, anti-inflammatory, anti-diabetic and anti-microbial agent (Gopalakrishnan *et al*., 2016). Tisane made

from the leaves also possesses essential micronutrients (Ilyas *et al.,* 2015; Okafor and Ogbobe, 2015).

Beetroot tea is another potential nutritious tisane containing alkaloids, steroids, flavonoids and many vitamins. Beetroot has anti-oxidant, anti-depressant, anti-microbial, anti-fungal, anti-inflammatory, diuretic, expectorant and carminative effects (Jasmitha *et al.,* 2018). Consumption of red beet product has been reported to cause beneficial physiological effect on nearly all organs of the digestive tract: pancreas, liver, colon (Babarykin *et al.,* 2019).

Research reports on the quality of various categories of commercial-tisanes in Nigerian market are either unavailable or scarce. Therefore, the objective of this research is to comparatively evaluate quality properties of powders and extracts of different types of commercial tisanes from cinnamon (bark), beetroot (root), *Moringa* (leaves) and *Hibiscus sadariffa* (flower) available in Nigerian, in order to offer an insight into the nutrient profile of these teas. This would be beneficial firstly, to the food regulators in coming up with documented *in vivo* scientific data on potential local tisanes; secondly, to the scientists in encouraging more studies on local tisanes which have potentials in addressing different health needs; and thirdly, to health conscious consumers in making the right choices of health beneficial tisanes.

MATERIALS AND METHODS

Sample collection

Different types of tisanes (*Hibiscus sadariffa*, Cinnamon, Moringa and Beetroot) and lipton tea used for this study were purchased from accredited marketer (Shoprite Mall, Lagos State Nigeria), while analytical grade reagents and equipment were obtained from Biochemistry Laboratory of National Root Crops Research Institute, Umudike.

Sample preparation

The teas were divided into two portions; the first portions in tea-bags (30g each) were infused in 50ml of boiling water at 100^{o}C for 3 min to obtain their extracts. The second portions of teas were removed from their bags and separately milled using a blender. Thereafter, they were passed through aluminium sieve (1mm) to get uniform particle size powder and were separately analysed with the extracts (Fig. 1).

Fig. 1: Different tea extracts
Key: Lipton Tea = LT- Tisane; Moringa Tea = MT- Tisane; Beetroot Tea = BT- Tisane; Hibiscus Tea = HT- Tisane and Cinnamon Tea = CT- Tisane.

Proximate analysis
The moisture, crude protein, crude fibre, fat, ash and carbohydrate contents of the tisane powders were evaluated using AOAC (2010) method.

Physicochemical analysis
The pH, titratable acidity, total solids and specific gravity were determined by the methods of AOAC (2010). The colour variance relative to pure water was determined using colorimeter and total sugars were determined using the procedure of Lokonuzzaman *et al*. (2015).

Phytochemical analysis
Aluminium chloride complex forming assay as described by Shannon *et al*. (2018) was used in the determination of total flavonoid content. The method of AOAC (2010) was used in the determination of total tannin. The total content of anthocyanin was reported as milligrams of cyanidin-3-glucoside (C3G) per litre of sample using the protocol of Flores-Martinez *et al*. (2018).

Antioxidant activity
The DPPH (2,2-diphenyl-1-picrylhydrazyl) antioxidant capacity was evaluated using the method described by Nino-Medina *et al*. (2017) and the FRAP (ferric reducing antioxidant power) antioxidant capacity was determined by the method of Lopez-Contreras *et al*. (2015).

Mineral analysis

The mineral content was evaluated by methods of Onwuka (2018). Calcium and magnesium contents were determined by the complexiometric titration; zinc was quantified using Atomic Absorption Spectroscopy (AAS); potassium and sodium were quantified using the flame photometry.

Vitamin analysis

The spectrophotometric method as described by Onwuka (2018) was employed in the determinations of pro-vitamin A, thiamine (B_1), riboflavin (B_2), niacin B_3 and vitamin C contents of the samples.

Statistical analysis

The data obtained were in triplicates and the results were subjected to one-way analysis of variance and expressed as mean with standard deviation. The differences between means were separated by Duncan's Multiple Range Test using International Business Machine Cooperation (IBM) Statistical Package for Social Sciences (SPSS) (Version 19.0) Statistics Programme, Illinois, USA. Significant differences were expressed at 5% level.

RESULTS

Proximate composition of tea powders is presented in table 1. Tea samples showed significant ($p<0.05$) differences in all the proximate parameters measured. The moisture, protein, fat, fibre, ash and carbohydrate contents ranged from 3.21 – 4.74%, 1.17 – 7.93%, 0.45 – 2.65%, 2.48 – 10.91%, 1.52 – 5.64% and 75.62 – 89.69%, respectively. HT- Tisane had the highest moisture content (4.74%) while CT- Tisane had the lowest moisture (3.21%). In protein MT- Tisane had the highest value (7.93%), this was followed by HT- Tisane (5.49%); while LT- Tisane had the lowest protein (1.17%). LT- Tisane was significantly ($p<0.05$) high in fat (2.65%), fibre (10.91%), and ash (5.64%); however, significantly low in carbohydrate.

Table 1: Proximate composition of tea powders (%)

Sample	Moisture	Protein	Fat	Fibre	Ash	Carbohydrate
MT	[illegible]^{b}±0.10	7.93^{a}±0.10	1.64^{c}±0.11	2.48^{e}±0.01	5.09^{b}±0.18	78.84^{d}±0.15
CT	3.21^{e}±0.15	3.11^{c}±0.11	2.42^{b}±0.10	9.35^{b}±0.01	2.34^{d}±0.13	79.57^{c}±0.18
BT	3.63^{d}±0.11	2.07^{d}±0.10	0.45^{e}±0.01	2.64^{d}±0.01	1.52^{e}±0.10	89.69^{a}±0.17
HT	4.74^{a}±0.12	5.49^{b}±0.14	0.71^{d}±0.01	3.96^{c}±0.01	3.35^{c}±0.15	81.75^{b}±0.18
LT	4.01^{c}±0.11	1.17^{e}±0.01	2.65^{a}±0.12	10.91^{a}±0.08	5.64^{a}±0.16	75.62^{e}±0.16

Values are mean ± SD of replicates; Column with different superscript are significantly different ($p<0.05$); MT – Moringa tea, CT – Cinnamon tea, BT – Beetroot tea, HT – Hibiscus tea, LT- Lipton tea

The mineral composition of the tea powders is presented in table 2. Tea samples were significantly different ($p<0.05$) in the minerals determined in this study. The calcium, magnesium, sodium, potassium and zinc contents ranged from 57.66 – 98.88%, 13.89 – 43.26%, 1.66 – 13.44%, 123.52 – 190.38% and 0.47 – 1.925, respectively. MT- Tisane was found to be significantly ($p<0.05$) high in calcium (98.88%) and sodium (13.44%); while BT-Tisane had the least calcium (68.57%) and LT- Tisane having the lowest sodium (1.66%). LT-Tisane had the highest magnesium (43.26%) and it was followed by CT- and BT- Tisanes which had 41.98% and 27.17%, respectively. BT- Tisane had the highest potassium (190.38%). This is followed by MT- and CT- Tisane with 183.02% and 138.64% respectively. In zinc availability, CT- Tisane was the highest (1.92%); while HT- Tisane had the least value (0.47%).

Table 2: Mineral content of tea powders (mg/100g)

Sample	Calcium	Magnesium	Sodium	Potassium	Zinc
MT	98.88^{a}±0.23	36.06^{d}±0.18	13.44^{a}±0.14	183.02^{b}±0.25	0.92^{c}±0.02
CT	79.96^{b}±0.20	41.98^{b}±0.24	2.42^{e}±0.12	138.64^{c}±0.44	1.92^{a}±0.03
BT	68.57^{e}±0.22	27.17^{c}±0.32	2.85^{c}±0.13	190.38^{a}±0.36	0.67^{d}±0.02
HT	57.66^{d}±0.18	13.89^{e}±0.23	4.74^{b}±0.14	123.52^{e}±0.23	0.47^{e}±0.01
LT	77.44^{c}±0.25	43.26^{a}±0.30	1.66^{d}±0.11	129.77^{d}±0.44	1.08^{b}±0.03

Values are mean ± SD of replicates; Column with different superscript are significantly different ($p<0.05$); MT – Moringa tea, CT – Cinnamon tea, BT – Beetroot tea, HT – Hibiscus tea, LT-Lipton tea

The selected phyto-nutrients content of the tea powders is shown in table 3. The flavonoid, anthocyanin and tannin contents ranged from 2.54 – 4.78%, 1.44 – 2.24% and 1.43 – 2.34%, respectively. Samples showed marked variability in their phyto-nutrients composition. In flavonoid, HT-Tisane had the highest (4.78%) content. This was followed by BT-, MT- and LT-Tisanes which had 3.44%, 3.23% and 3.09%, respectively. However, CT- Tisane had the lowest (2.54%). The anthocyanin content of HT- Tisane was the highest (2.24%) while that of LT- Tisane (1.44%) was the lowest. MT- Tisane showed superiority in tannin content (2.34%) this was followed by BT- and LT- Tisanes which had 2.12% and 1.72%, respectively. However, HT- Tisane had the lowest tannin (1.43%).

Table 3: Phytonutrient content of tea powders

Sample	Flavonoid (mgQE/g)	Anthocyanin (mg/100g)	Tannin (mg/100g)
MT	3.23^{c}±0.02	1.86^{c}±0.03	2.34^{a}±0.04
CT	2.54^{e}±0.04	2.08^{b}±0.02	1.45^{d}±0.02
BT	3.44^{b}±0.03	1.73^{d}±0.01	2.12^{b}±0.03
HT	4.78^{a}±0.02	2.24^{a}±0.03	1.43^{e}±0.02
LT	3.09^{d}±0.03	1.44^{e}±0.01	1.72^{c}±0.01

Values are mean ± SD of replicates; Column with different superscript are significantly different ($p<0.05$); MT – Moringa tea, CT – Cinnamon tea, BT – Beetroot tea, HT – Hibiscus tea; LT-Lipton tea

The physicochemical parameters of the tea extracts are shown in table 4. Tea extracts showed marked variability in all the parameters measured. The pH, total titratable acidity, total solid, total sugar, specific gravity and colour variance ranged from 3.33 – 4.63%, 0.55 – 0.98%, 95.26 – 96.87%, 0.02 – 0.16% 0.95 – 1.11% and 59.18 – 97.97%, respectively. In pH, MT-Tisane had the highest values (4.63) while HT- Tisane was the least (3.33%). In total titratable acidity, that is predominant acid, HT- Tisane had the highest content (0.98%) while CT- Tisane was the lowest (0.55%). CT- and BT- Tisanes were found to be statistically similar and higher in total solid 96.35% and 96.87%, respectively. MT-Tisane (95.98%) and LT- Tisane (95.99%) ranked second in total solid; while HT-Tisane had the lowest value (95.26%). CT-Tisane had significantly ($p<0.05$) higher total sugar (0.16%) while HT- Tisane had the lowest (0.02%) value. MT-, CT- and BT-Tisanes were statistically similar and higher in specific gravity than HT- and LT-Tisanes. BT- Tisane was significantly ($p<0.05$) higher in colour variance (97.97%) while CT- Tisane had the least colour variance (59.18%).

Table 4: Physicochemical content of tea extracts

Sample	pH	Total titratable acidity (%)	Total solid (%)	Total Sugar (%)	Specific gravity	Colour Variance (%)
MT	4.63^{a}±0.23	0.64^{b}±0.02	95.98^{b}±0.43	0.07^{b}±0.01	1.00^{a}±0.02	34.67^{d}±0.11
CT	4.85^{c}±0.25	0.55^{e}±0.01	96.35^{a}±0.54	0.16^{a}±0.02	1.00^{a}±0.03	59.18^{e}±0.14
BT	4.11^{d}±0.21	0.70^{d}±0.03	96.87^{a}±0.41	0.07^{b}±0.03	1.11^{a}±0.02	97.97^{a}±0.14
HT	3.33^{e}±0.24	0.98^{a}±0.02	95.26^{c}±0.62	0.02^{d}±0.01	0.95^{b}±0.01	93.57^{b}±0.12
LT	5.35^{b}±0.21	0.32^{c}±0.01	95.99^{b}±0.41	0.04^{c}±0.01	0.97^{b}±0.01	90.32^{c}±0.13

Values are mean ± SD of replicates; Column with different superscript are significantly different ($p<0.05$); MT – Moringa tea, CT – Cinnamon tea, BT – Beetroot tea, HT – Hibiscus tea; LT-Lipton tea

The vitamin contents of the tea extracts were presented in table 5. Tea extracts showed marked variability in all the vitamins determined in this study. Vitamins A, B_1, B_2, B_3 and C ranged from 0.001 – 0.028 µg, 0.10 – 0.45 mg, 1.20 – 2.20 mg, 0.51 – 0.91 mg and 3.44 – 7.09 mg, respectively. Quantitatively vitamins A, B_1 and B_3 were low in the tea extracts; while there were appreciable amounts of vitamin B_2 and vitamin C. CT- Tisane was significantly ($p<0.05$) higher in vitamin A (0.028 µg). This was followed by BT- and MT- Tisanes which had 0.020 µg and 0.014 µg, respectively. However, HT- Tisane had the lowest vitamin A (0.001 µg). In the same vein, CT- Tisane had the highest vitamin B1 (0.45 mg). However, BT-Tisane had the lowest vitamin B_1 (0.10 mg). BT- Tisane was significantly ($p<0.05$)

higher in vitamin B_2 (2.20 mg). MT- Tisane ranked second in vitamin B_2 (2.00 mg); while, CT- and HT- Tisanes both ranked third where they had 1.40 mg and 1.80 mg, respectively. CT- Tisane was significantly ($p<0.05$) higher in vitamin B_3 (0.91 mg); while, HT- Tisane had the lowest (0.51 mg) value. In vitamin C, MT- Tisane had the highest value (7.09 mg). These were followed by HT- Tisane (6.13 mg), BT-Tisane (5.35 mg); while CT- Tisane (3.44 mg) was the lowest.

Table 5: Vitamin content of tea extracts

Samples Code	Vitamin A (µg)	Vitamin B_1 (mg)	Vitamin B_2 (mg)	Vitamin B_3 (mg)	Vitamin C (mg)
MT	0.014^{c}±0.01	0.39^{b}±0.02	2.00^{b}±0.11	0.61^{d}±0.01	7.09^{a}±0.15
CT	0.028^{a}±0.01	0.45^{a}±0.03	1.40^{c}±0.10	0.91^{a}±0.02	3.44^{e}±0.12
BT	0.020^{b}±0.01	0.10^{d}±0.02	2.20^{a}±0.12	0.84^{c}±0.03	5.35^{c}±0.13
HT	0.001^{e}±0.01	0.19^{c}±0.01	1.80^{c}±0.11	0.51^{e}±0.01	6.13^{b}±0.14
LT	0.002^{d}±0.01	0.33^{b}±0.02	1.20^{d}±0.10	0.85^{b}±0.02	4.82^{c}±0.13

Values are mean ± SD of replicates; Column with different superscript are significantly different ($p<0.05$); MT – Moringa tea, CT – Cinnamon tea, BT – Beetroot tea, HT – Hibiscus tea, LT-Lipton tea

The antioxidant (DPPH) and reducing power of the tea extract are shown on table 6. BT- and HT- tea extracts were significantly ($p<0.05$) higher in DPPH 90.85% and 90.06% respectively. MT- and CT- tea extracts followed in antioxidant capacities 88.33% and 86.15% respectively. CT- tea extracts had the lowest antioxidant activity (86.15%). In reducing power, LT- tea extract had the highest activity (60.65 µmol) followed by MT- extract (56.77 µmol) and CT- and BT- tea extracts which had 55.45 µmol and 54.13 µmol, respectively. LT- tea extract had the least activity 51.22 µmol.

Table 6: Antioxidant properties of tea extracts

Sample	DPPH (%)	FRAP (µmol)
MT	88.33^{b}±0.34	56.77^{b}±0.54
CT	86.15^{c}±0.44	55.45^{c}±0.63
BT	90.85^{a}±0.32	54.13^{c}±0.64
HT	90.06^{a}±0.42	60.65^{a}±0.44
LT	73.77^{d}±0.23	51.22^{d}±0.52

Values are mean ± SD of replicates; Column with different superscript are significantly different ($p<0.05$); MT – Moringa tea, CT – Cinnamon tea, BT – Beetroot tea, HT – Hibiscus tea, LT-Lipton tea.

DISCUSSION

The moisture content of the tisane powders ranged from 3.21% (cinnamon) to 4.7%4 (hibiscus). This is within the acceptable limits for extended storage of powdered foods (3 - 12% (w/w) (Barbosa *et al*., 2008). This is an indication that all the tea samples have potentials of shelf stability prior to use. The result agrees with Mabai *et al*. (2018) who reported a moisture content of 2.10 - 5.00% for lemon grass tea. However, for the optimal quality of the tea products, moisture percentage should be maintained between 2.5 - 6.5% (Yao *et al*., 2006). The shelf stability of food products depends on the moisture content, such that the higher the moisture contents, the lower the shelf stability vice versa (Mabai *et al*., 2018). Therefore, low moisture content of the teas in this study is an indication that they might be less susceptible to microbial attack. Protein was least in the control (lipton powder) 0.17% and highest in Moringa (MT) powder (7.93%). Hibiscus tisane was second highest in protein (5.49%). The result strongly agrees with the findings of Gopalakrishnan *et al*. (2016) who reported 6.7% protein in fresh leaves of Moringa. In the same vein, Deshmukh *et al*. (2018) reported protein content of 1.67% in beetroot leaves.

Protein is an important macro-nutrient in human being and source of amino-acids for the synthesis of the body protein. Though the tea powders are not consumed directly, but some protein get leached into the tea infusion. Eugene *et al*. (2015) reported that there is an inverse relationship between protein intake and risk of coronary heart disease.

The fat content of the tea products ranged from 0.45% (beetroot tisane) to 2.65% (lipton tea). The result showed that fat content of the tea powders is low. The tisane powders had lower fat content (0.71 - 2.32%) than the control lipton tea (2.65%). The low fat content in this study is in line with the findings of Adnan *et al*. (2013) reported similar fat content (0.94 - 2.15%) in commercial green and black teas. Ndife (2016) reported that low fat content in a dry product will help in increasing the shelf life of the product by decreasing the chances of rancidity and also, contributes to low energy value in food products while, high fat content product will have high energy value and promote lipid oxidation.

Moringa tisane had the least crude fibre (2.48%) and cinnamon tisane had the highest (9.35%) for the different commercial tisanes. Fibre content of 11.23-17.21% was reported for commercial green and black teas (Adnan *et al*., 2013). High fibre content of Lipton tea powder revealed that the product is made of fibrous materials which could affect leaching. Dietary fibre facilitates peristalsis which helps to reduce many gastrointestinal diseases, serum cholesterol, risk of coronary heart diseases, colon and breast cancer and hypertension (Wardlaw, 2004), if consumed whole. There is positive association between fibre content and keeping quality of the tea and proposed fibre content of less than 16.5%, in order to maintain high quality of tea during storage (Smiechowska and Dmowski, 2006).

The ash content of the tisane powders (1.52

- 5.09%) were higher than that of the Lipton tea (5.64%). Beetroot tisane (MT) had the lowest fibre content (1.52%) followed by cinnamon tisane (2.34%). There was significant difference in ash content of the tisane powders. Adnan *et al*. (2013) reported higher ash content (32.34-53.61%) in commercial teas. Ash is an important parameter in tea quality. Ismail *et al*. (2000) and Rehman *et al*. (2002) reported positive correlations between ash content and quality of tea. Rehman *et al*. (2002) proposed that ash content should be less than 5.54% to maintain tea quality during storage. Only Lipton tea met this suggestion. The ash content of food material could be used as an index of mineral constituents of the food because ash is the inorganic residue remaining after the water and organic matter have been removed (Onwuka, 2018).

Carbohydrate was highest in Beetroot tisane (89.69%), followed by Hibiscus Tisane (81.83%), Cinnamon (79.57%) and Moringa (78.84%) and least in Lipton tea (76.62%). As carbohydrate was calculated by difference, it showed that products higher in other parameters would have low carbohydrate content. High carbohydrate content of the tisanes of more than 75% is supported by findings of Deshmukh *et al*. (2018).

The mineral composition of tea powders showed that calcium, magnesium, sodium and potassium. Moringa tisane had calcium (98.88%), sodium (13.44%) and potassium (183.02%) contents.

The calcium content of the tisanes is significantly higher compared with 2.99 - 3.84 mg/l in green tea and 1.46 - 2.81 mg/l in black tea (Adnan *et al.,* 2013). However, the magnesium content compares favourably with 4.78 - 5.66 mg/l in green tea and 2.97 - 4.80 mg/l in black tea. They attributed higher calcium content in green tea samples to the use of fresh tea leaves in the processing of green tea as compared to black tea. The high potassium content in this research might be correlated with cultivation of tea in potash-rich soils (Jonah and Williams, 2000). Minerals are crucial for the interaction between genetic and physiological factors. If a dietary deficiency of these elements exists, it will lead to physiological and structural abnormalities that are preventable and which may be reversed by administration of the element (Obiajunwa *et al*., 2002, Adnan *et al*., 2013; Flores-Martinez *et al.,* 2018).

The total flavonoid of the tisanes ranged from 2.54 to 4.78 mgQE/g compared with 3.09 mgQE/g for lipton (LT) powder. Hibiscus powder (BT) had the highest flavonoid (4.78 mgQE/g) followed by beetroot (BT) powder (3.44 mgQE/g). Nibir *et al.* (2017) reported total flavonoid content of 6.78 - 8.84 mg/100 g for different black tea grades which is higher compared with the range obtained in this study. Higher flavonoid has been reported in green tea (5 - 10%) and black tea (6 - 8%) (Ndife *et al*, 2019). Flavonoids are powerful antioxidants that have inflammatory and immune system benefits. Foods with high flavonoid are associated

with diseases prevention.

Anthocyanin was lowest in Lipton powder (1.44 mg/100g) and higher in tisane powders (1.73 – 2.24 mg/100g). Among the tisane powders, Beetroot (BT) had the lowest anthocyanin of 1.73 mg/100g. There was significant difference ($p<0.05$) in the anthocyanin content of the samples. Anthocyanin is efficacious against reactive oxygen species which causes oxidative stress (Ndife, 2016). They can efficiently remove free radicals and induce a strong antioxidant activity in cells from various organisms due to content of numerous phenolic hydroxyl groups and have therefore, considered as functional substances in anti-aging, suppressing cancer tumours, reducing blood lipid level, liver protection and performing other physical effects in humans (Kerio *et al.,* 2013; Lim *et al*., 2013; Chen *et al*., 2015). The level of anthocyanin recorded for different tisane brands is an indication that anthocyanin is predominantly found in coloured teas (Flores-Martinez *et al*., 2018). Maximum values of phytochemical extraction of fruit teas were reported at 100°C by Sivakumaran and Amarakoon, (2017).

The tannin content showed the range of 1.43 (Hibiscus tisane) to 2.34 (Moringa tisane). Tannins are responsible for the astringent taste of teas (Ndife, 2016). Higher tannin range of 11.76-15.15% has been reported for black teas, 2.65-3.11% for green teas while commercial green teas contained average of 8.66% tannin (Ndife *et al*., 2019). Tannins in teas has been reported to be antioxidants and anti-carcinogens, and have been found to reduce the mutagenic activities of a number of mutagens in foods (Chung *et al*., 1998).

The pH of the tisane extracts ranged from 3.33 to 4.85 which showed that they are acidic in nature. Hibiscus tisane with pH of 3.33, was the most acidic compared to other brands of tisane.

Therefore, it is imperative to dilute the teas (especially tea with pH below 4) with water to lower their acidity before consumption. Chaudhary and Maurya (2019) reported pH of 4.9-5.5 (black tea), 7-10 (green tea), 3.0 (lemon tea) and 6-7 (mint, fennel, chamomile teas). The low pH of the tisane samples suggests better stability while in storage as pH has been reported to be one of the important quality characteristics that affect the stability of bioactive compounds in tea products (Ndife *et al*., 2019). The safe pH level for drinks that will not cause tooth damage is considered around 5.5 (Wardlaw, 2004).

The tisane samples (0.55-0.98%) were more acidic than control lipton tea (0.32%). Flores-Martınez *et al.* (2018) reported TTA range of 0.092 to 0.174% for ready-to-drink flavoured-coloured commercial teas. pH as an indicator of acidity is reported to also affect microbial activity (Ndife, 2016). The ratio of sugars to acids and vice-versa gives an accurate prediction of the tartness and sweetness of acid foods which affects organoleptic perception (Ndife, 2016). Titratable acidity is a better indicator of the likely effect of acid content on flavour of food.The total (soluble and non-soluble) solids content of the tisane extracts ranged from 95.26% (Hibiscus tisane) to 96.79%

(Cinnamon tisane).. Beetroot tisane (96.87%) had the highest total solids followed closely by Cinnamon (96.35%). Higher total solids are used in characterizing the quality of juice and other beverage products (Wardlaw, 2004).

Cinnamon extract recorded highest value (0.16%) in total sugar content, while Hibiscus extract was least (0.02%). Result of total (reducing and non-reducing) sugars revealed that the tisane extracts are very low in sugar content, which would be ideal for patients with sugar-related issues.

Specific gravity range of 0.95 - 1.11 of teas was recorded in this work. Ndife *et al.* (2019) reported specific gravity of 1.01 - 1.71 for different types of tea extracts. Colour intensity of the tisane extracts ranged from 9.18 (Cinnamon tisane) to 97.97 (Beetroot tisane). The different colour variances (intensities) relative to pure water, observed for the tea extracts could be attributed to their polyphenol, carotenoids and chlorophyll components and the level of extracted substances (Wardlaw, 2004; Ndife, 2016).

The tea extracts were very low in carotenoid pro-vitamin A (0.001 - 0.028 µg/g). Ndife *et al.* (2019) reported Vitamin A content of 20.37 in black *Moringa* tea and 8.12 (β-carotene eq/mg) for green *Moringa* tea. Though vitamin A has been reported to be heat stable, the low detection could be attributed to its poor solubility in water. Vitamin A plays critical roles in vision, bone growth and reproduction (Wardlaw, 2004; Ndife, 2016).

The ranges of 0.09 - 4.48, 0.018 - 0.22 and 0.01 - 0.41 mg were recorded for vitamins B_1, B_2 and B_3 respectively. Okafor and Ogbobe (2015) reported ranges for vitamin A (7.35-20.37 mg), Vitamin B_1 (0.11-2.85 mg), B_2 (0.07-21.46 mg) and C (8.25-213 mg) in green and black *Moringa* tea leaves.

The tea extracts had higher vitamin C (ascorbic acid) contents (3.44 – 7.09 mg) than B- vitamins (0.01-2.20 mg). Similarly, Ndife *et al*. (2019) reported higher vitamin C (8.02-14.52 mg) than B-vitamins (0.21-5.36 mg) in all tea samples analysed. Vitamin B and C are water soluble vitamins and are heat labile (Ndife, 2016; Onwuka, 2018). The tea extracts would be important in delivery of body fluid and essential micro-nutrients such as these vitamins (Ndife, 2016) and the nutritional significance of vitamins is related to their contribution to the recommended dietary allowance (RDA) (Wardlaw, 2004).

All the herbal tisanes recorded 86.15 to 90.85 DPPH activity. This revealed that the tisane extracts had good scavenging activity on reactive oxygen species. Shannon *et al.* (2018) reported higher percentage antioxidant capacities for green, black, and white teas of 79.41%, 55.49%, and 26.14% respectively. Berry and chamomile teas' DPPH of 53.34% and 30.53% was also reported by Shannon *et al.* (2018) which were lower than values recorded in this work.

The result of the ferric reducing antioxidant power (FRAP) of tisane extracts ranged from 54.13 µmol (Moringa Tisane) to 60.65 µmol/ml (Lipton tea). This confirms that the extract is capable of reducing oxidative stress, caused by reactive oxygen species, which would help maintain the integrity of

the cellular processes. Lower values of 37.96 (berry tisane) and 24.57 (chamomile) were reported by Shannon *et al.* (2018). FRAP of 124µg TE/g was reported for Hibiscus-based tea (Sayago-Ayerdi *et al*., 2007), which is higher than 60.65µmol/ml recorded in this work for Hibiscus tisane. Antioxidants are compounds that inhibit oxidation. Oxidation is a chemical reaction that can produce free radicals, thereby leading to chain reactions that may damage the cells of organisms. Antioxidants such as ascorbic acid terminate these chain reactions (Ndife, 2016). Moreover the antioxidant capacity of tea is not related to only polyphenols but to the combined activity of diverse antioxidant compounds including phenolic acids (Onwuka, 2018; Ndife, 2016; Ravikumar, 2014). This tisane extracts are more capable of scavenging and reducing oxidative stress, caused by reactive oxygen

CONCLUSION

This research has provided preliminary data on selected categories of commercial tisanes in Nigerian market. The results obtained showed that the tisanes had better nutritive values, comparable physiochemical qualities and higher antioxidant capacities (DPPH and FRAP) than regularly consumed lipton tea from *Camellia sinensis* leaves. Among the tisanes, *Moringa* and *Hibiscus* had higher nutrients and phytochemicals. Hibiscus was the most acidic among the teas. The Herbal teas were of good quality, with high antioxidant and scavenging activities which will give physiological benefits. The combined effects of the nutritive and complex bioactive components must be considered in the overall health benefit of tisanes. An increase in the consumption of tisanes with negligible calorie should be encouraged to enhance healthy body functions

REFERENCES

Adnan, M., Ahmad, A., Ahmed, A., Khalid, N., Hayat, I. and Ahmed, I. (2013). Chemical composition and sensory evaluation of tea (*Camellia sinensis*) commercialized in Pakistan. *Pakistan Journal of Botany.* 45(3): 901-907.

AOAC (2010). Official Methods of Analysis. Association of Official and Analytical Chemists. 18th Edition. Washington DC., USA.

Babarykin, D., Smirnova, G., Pundinsh, I., Vasiljeva, S., Krumina, G. and Agejchenko, V. (2019). Red beet (*Beta vulgaris*) impact on human health. *Journal of Biosciences and Medicines*. 7: 61-79.

Chaudhary, N. and Maurya, N. K. (2019). An overview of potential health benifits of tea. AkiNik Publications, Rohini, Delhi – 110085, India.

Chandrasekara, C. M. and Shahidi, F. (2018). Herbal beverages: Bioactive compounds and their role in disease risk reduction - A review. *Journal of Traditional and Complementary Medicine.* 8(4): 451-458.

Chen, J., Zhao, Y., Tao, X. Y., Zhang, M. and Sun, A.D. (2015). Protective effect of blueberry anthocyanin in a CCL_4-induced liver cell model. *Food Science and Technology*. 60(10): 1105-1112.

Chung, K., Wong, T.Y., Wei, Y.H and Lin, Y. (1998). Tannins and human health: A review. *Critical Reviews in Food Science and Nutrition*. 38(6): 421-464.

Deshmukh, G. P., Priyanka, A., Sindhav, R. and Jose, N. (2018). Application of beetroot as natural coloring pigment and functional ingredient in dairy and food products. *International Journal of Current Microbiology and Applied Sciences.* 7(12): 2010-2016.

Eugene N. Onyeike, Ernest A. Anyalogbu, Michael O. and Monanu (2015). Effect of heat processing on the proximate composition and energy values of african walnut (*plukenetia conophora*) and african elemi (*Canarium schweinfurthii*) consumed as masticatories in Nigeria. *International Journal of Scientific and Technology Research.* 4(8): 295-301.

Flores-Martinez, D., Urías-Orona, Hernández-García, V., Rubio-Carrasco, W., Silva-Gutiérrez, K., Guevara-Zambrano, M., Prieto-Cadena, J., Serna-Méndez, T., Muy-Rangel, D. and Niño-

Medina, G. (2018). Physicochemical parameters, mineral composition, and nutraceutical properties of ready-to-drink flavored-colored commercial teas. *Journal of Chemistry.* pp. 1-7.

Gopalakrishnan, G., Doriya, K and Kumar, D. S. (2016). *Moringa oleifera*: A review on nutritive importance and its medical application. *Food Science and Human Wellness.* 5(2): 49-56.

Ho, C.T., Lin, J.K. and Shahidi, F. (2008). Tea and tea products: chemistry and health-promoting properties. Boca Raton: CRC Press.

Ilyas, M., Arshad, M. U., Saeed, F. and Iqbal, M. (2015). Antioxidant potential and nutritional comparison of *Moringa* leaf and seed powders and their tea infusions. *The Journal of Animal and Plant Sciences.* 25(1): 226-233.

Islam, A. K. A. M., Jamini, T. S., Islam, A. K. M. M. and Yeasmin, S. (2016). Roselle: A functional food with high nutritional and medicinal values. *Fundamental and Applied Agriculture.* 1(2): 44-49.

Ismail, M., Barber, E., Md Danial, A., Rahmat, A. and Yahaya, A. (2000). Chemical composition and antioxidant activity of *Strobilanthes crispus* leaf extract. *The Journal of Nutritional Biochemistry*. 11(11-12):536-542

Jasmitha, S.K., Ahok, S. and Karunakar, H. (2018). A review on *Beta vulgaris* (Beet Root). *International Journal of Pharma and Chemical Research,* 4(2): 136-140.

Juneja, L.R., Kapoor, M.P., Ohkubo, T., Theertham, P.R. (2013). Green tea: History, processing techniques, principles, traditions, features and attractions. Publisher: CRC Press, USA.

Jonah, S.A. and Williams, I.S. (2000). Nutrient elements of commercial tea from Nigeria by an instrumental neutron activation analysis technique. *Science of the. Total Environment.* 258(3): 205-208.

Kasolo, J. N. Bimenya, G. S. Ojok, L. Ochieng, J. Ogwal-okeng, J. W. (2010). Phytochemicals and uses of *Moringa oleifera* leaves in Ugandan rural communities, *Journal of Medicinal Plants Research.* 4: 753–757.

Kerio, L., Wachira, F.N., Kanyiri, W.J. and Rotich, M.K. (2012). Characterization of anthocyanins in Kenyan teas: Extraction and identification. *Food Chemistry*.

131(1):31–38.

Lokonuzzaman, A., Nazrul, I. and Saidul, I. (2015). A quantitative estimation of the amount of sugar in fruits jam available in Bangladesh. *Science Journal of Analytical Chemistry.* 3(5): 52-55.

Lopez-Contreras, J. J., Zavala-García, F., Urías-Orona, V., Martínez-Ávila, G. C. G., Rojas, R. and Niño-Medina, G. (2015). Chromatic, phenolic and antioxidant properties of Sorghum bicolor genotypes. *Notulae Botanicae Horti Agrobotanici Cluj-Napoca*. 43(2): 366.

Lim, S., Xu, J., Kim, J., Chenn, T. Y., Su, X., Standard, J. Carey., E., Griffin, J., Herndon, B and Katz, B. (2013). Role of anthocyanin-enriched purple-fleshed sweet potato p40 in colorectal cancer prevention. *Molecular Nutrition and Food Research.* 57(10): 1908-1917.

Mabai, P., Omolola, A. and A. I. O. Jideani, (2018). Effect of Drying on Quality and Sensory Attributes of Lemongrass (*Cymbopogon Citratus*) Tea. *Journal of Food Research*. 7(2): 68-76

Maheshwari, R. K., Chauhan, A. K., Gupta, A. and Sharma, S. (2013). Cinnamon: An imperative spice for human comfort. *International Journal of Pharmaceutical Research and Bio-Science.* 2(5):131-145.

Ndife J. (2016). Functional Foods: Basics, Ingredients and Applications. Amotes Link Services and Publishers, Kaduna, Nigeria

Ndife, J., Uka, N.C. and Ukom, N.A. (2019). Development and comparative evaluation of green and black tisanes using scent leaves (*Chromolaena odorata*). *Food Research*. 3 (5): 448 – 455.

Nibir Y. M *et al*. (2017). Comparative assessment of total polyphenols, antioxidant and antimicrobial activity of different tea varieties of Bangladesh. *Asian Pacific Journal of Tropical Biomedicine*. 7(4): 352-357.

Nino-Medina, G., Romo-Longoria, J. D., Ramirez-González, I. V., Martinez-Reyna, O. O. and Urias-Orona, V. (2017). Phenolic content and antioxidant capacity level in commercial Mexican lager beers. *Journal of the American Society of Brewing Chemists.* 75(2): 156–158.

Obiajunwa, EI, A.C. Adebajo and O.R. Omobuwajo. (2002). Essential and trace element contents of some Nigerian medicinal plants. *Journal of Radioanalytical and*

Nuclear Chemistry. 252(3): 473-476.

Okafor, G. I. and Ogbobe, N. M. (2015). Production and quality evaluation of green and black herbal teas from *Moringa oleifera* leaf. *Journal of Food Resource Science.* 4(3): 62-72.

Onwuka, G.I. (2018). Food Analysis and Instrumentation. 2nd Edition. Theory and Practices. Naphtali Prints Lagos, Nigeria.

Ravikumar, C. (2014). Review on herbal teas. *Journal of Pharmaceutical Sciences and Research.* 6(5): 236-238.

Rehman, S.U., K. Almas, N. Shahzadi, N. Bhatti and A. Saleem. (2002). Effect of time and temperature on infusion of tannins from commercial brands of tea. *International Journal of Agriculture and Biology.* 4(2): 285-287.

Sayago-Ayerdi, S.G., Arranz, S., Serrano, J. and Goni, I. (2007). Dietary fiber content and associated antioxidant compounds in roselle flower (*Hibiscus sabdariffa* L.) beverage. *Journal of Agricultural and Food Chemistry.* 55(19), 7886-7890.

Shannon, E., Jaiswal, A.K. and Abu-Ghannam, N. (2018). Polyphenolic content and antioxidant capacity of white, green, black, and herbal teas: a kinetic study. *Food Research.* 2 (1): 1 – 11.

Smiechowska, M. and P. Dmowski. (2006). Crude fibre as a parameter in the quality evaluation of tea. *Food Chemistry.* 94(3): 366-368.

Sivakumaran, K. and Amarakoon, S. (2017). Bioactivity of fruit teas and tisanes – A review. *Journal of Pharmacognosy and Phytochemistry.* 7(1): 323-327.

Wardlaw, G. M. (2004). Perspectives in Nutrition. (6th ed.) McGram Hill Companies, New York, U.S.A.

Yao, L., Liu, X., Jiang, Y., Caffin, N., D'Arcy, B.C., Singanusong, R., Datta, N and Xu, Y. (2006). Compositional analysis of teas from Australian supermarkets. *Food Chemistry*. 94(1):115-122.

Faculty of Agriculture, Ibrahim BadamasiBabangida University, Lapai 2022
Lapai International Journal of Agriculture Vol. 3(1) June,2022 pp 716-731
ISSN:2705-2869

ASSESSMENT OF FARMERS' SOCIO-ECONOMIC CHARACTERISTICS ON THE USE OF INFORMATION COMMUNICATION TECHNOLOGIES (ICTs) IN LAPAI LOCAL GOVERNMENT AREA OF NIGER STATE, NIGERIA

[1]Ubandoma, G.A., [1]Elejo, J. O, [2]Yakubu, D. H, [2]Haruna, S, [3]Ismail, H. A. and [4]Ahmad, M.

[1]Department of Agricultural Economics and Extension Services. Faculty of Agriculture, IBB University Lapai. Niger State, Nigeria.
[2]Department of Agricultural Extension and Rural Development. Faculty of Agriculture, Usmanu Danfodiyo University, Sokoto, Nigeria.
[3]Department of Agricultural Economics and Extension. Faculty of Agriculture, Federal University, Gashua, Nigeria.
[4]Department of Agricultural Extension and Rural Development. Faculty of Agriculture, Federal University, Gashua, Nigeria

Corresponding author: ubandomagarba7@gmail.com. 07060619690

ASTRACT

The study assessed the farmers' socioeconomic characteristics on the use of ICTs in Lapai Local Government Area of Niger State. Multistage random sampling technique was used to select a sample of ninety (90) respondents for the study. Primary data were collected with the aid of a structured questionnaires. Analysis of the data was through the use of descriptive statistics and regression analysis. The results revealed that most of the respondents were male, married, educated with the mean age of 54 years. The mean years of farming experience was 25years and the mean of household size was 11 people. Farming was considered as full-time occupation (78.9%) with mean of 3ha farmland acquired mostly through inheritance. The mean annual income was #91,727:00k and 57% extension contact. Most of the respondents were aware of ICTs. The commonly used ICTs were: radio, mobile phone, television and video. The information respondents obtained by using the ICTs were mostly personal information, only few were new innovation, agricultural programmes and farming technique. The constraints to the use of ITCs were: Poor ICTs knowledge and erratic network coverage. The sources of ICTs were: Personal and business center. The socioeconomic characteristics that were significantly related to the use of ICTs were: occupation, farm size significant ($p<0.01$) and farming experience ($p<0.05$). There is the need to enhance ICT infrastructural development and promote ICT education and training of the farmers on the use and important of ICTs to modern days agricultural practices were offered as recommendations.

Keywords: Farmers, Socioeconomic, ICTs, Lapai, Local Government Area, Niger state

Faculty of Agriculture, Ibrahim BadamasiBabangida University, Lapai 2022
Lapai International Journal of Agriculture Vol. 3(1) June,2022 pp 716-731
ISSN:2705-2869

INTRODUCTION

Information Communication Technologies (ICTs) refers to hardware, software, networks and media for collection, storage, processing, transmission and presentation of information in the format of voice, data; texts and images (World Bank, 2002). It also includes contemporary social networking aspects, read/write interfaces on the web besides file sharing systems online. It represents a broad and continually evolving range of elements that further includes the television (TV), radio, mobile phones and the policies and laws that governed the widespread use of these media and devices (Balaji *et al*.,2007). There are different ICTs including computers, internet, geographical information systems, mobile phones and traditional media (radio and television) which are used in delivering agricultural information to the farmers (Steinem *et al*., 2007). The potential of ICTs to contribute to agriculture and rural development has been well recognized (Singh, 2006). In different parts of the world ICTs are seen to have positively contributed towards rural development. Among others ICTs in use in Nigeria today include, but not limited to Radio, Television, Computer, internet, Global System of Mobile Telecommunication (GSM) and the Fixed Telephone Network (Spore, 2004).

Steinem *et al.*, (2007) indicated that extension workers use ICTs to gather, retrieve, adapt, localize and disseminate a broad range of information needed by rural families. Farmers who are hooked up to new technologies farmed better. ICT's boosts information supply on improved farm technologies and the resultant improved in productivity and income of farmers (Shah, 2009).

The search for an effective strategy for agricultural development calls for adequate use and application of ICTs, which are considered as among the principal drivers of economic growth and development worldwide (Abubakar and Abdullahi, 2009). In view of the above discussions, the study assessed the effect of farmers' socioeconomic characteristics on the use of ICT in Lapai Local Government Area of Niger State. The specific objectives are to: describe the farmer's socio-economic characteristics in the study area, examine the level of farmers' awareness and knowledge of ICT, identify the types of ICTs commonly used and the information obtained , know the sources of ICTs and identify the constraints associated with the use of ICTs. The relationship between the farmers' socioeconomic characteristics and the use of ICT will be consider as the hypothesis of the study.

MATERIALS AND METHODS

The study Area

The study was conducted in Lapai Local Government Area of Niger State, Nigeria. The area lies between latitude 6.2^{o}E and longitude 8,2^{o}N, it is situated at 75kms to the state capital (Minna). It has border with Agaie Local Government to the West, Kogi State to the South, Federal Capital and Gurara Local Government to the North. Lapai Local Government Area has a total population of about 117,020 people and

occupies a total area of about 3,051km^2 according to 2006 census (NPC, 2006).

Lapai Local Government Area comprises of eleven Districts and each of the districts is headed by a district head. The two major languages are Nupe and Dibbo. However, some minority tribes are found in different locations scattered in the area. Also, the Local Government has two distinctive seasons namely: wet and dry seasons. The wet season commences from April to October while the dry season commences from November to March respectively. The mean monthly temperature is mostly high and least in the month of August. The people are mostly farmers and the climate condition in the area favors the cultivation of variety of crops. The main crops cultivated in the area includes: rice, sorghum, maize, cassava, sesame, melon and yam (Niger state bureau of statistics, 2017).

Sampling Technique and Sample Size

The arable crops farmers in Lapai Local Government Area constituted the sample frame for the study. A multistage random sampling technique was used to select the respondents for the study. In the first stage, ten districts were randomly selected to form the blocks. This is because each of the districts represents a block of itself with eight (8) villages each. In the second stage, three villages were selected from each of the selected blocks to form thirty (30) cells for the study. In the final stage, three farmers were selected randomly from each of the cells to make a total of ninety (90) respondents for the study. A list of farmers was obtained from the Village Extension Agents.

Method of Data Collection

Both primary and secondary data were used for the study. The primary data were collected with aid of a structured questionnaire to be administered by the researcher with the help of trained enumerators who have the knowledge of a dialect of the respondents. The secondary data were obtained from project reports, textbooks, journals, internet, magazines, publications and consultation, library materials and other literatures relevant to the study.

Measurement of Study Variables

Two types of variables are were used for the study namely: the dependent and independent variables. The dependent variable is the use of ICT facilities while the independent variables are: farmers' socio-economic characteristics, farmers' level of ICTs awareness, types of ICT facilities use, the sources of ICT facilities and constraints associated with the use of ICT facilities.

Socio-economic Characteristics

Age: This is the number of years that have been spent from childhood to adulthood by the farmer. It was measured in the following categories: <20 years, 20-25 years, 26-30 years, 31-35 years, 36-40 years, >40 years.

Gender: This refers to individual sex which could be either male or female. It was measured as dummy variable with: male = 1, female =2.

Marital status: This refers to whether the farmer is married or singled. This is was determined using: Singled = 0, Married = 1, Divorced = 2, Widowed = 3.

Household size: This refers to the number of individuals living together in a household. This was measured in this way: <2 persons, 2-4 persons, 5-7 persons, 8-10 persons, >10 persons.

Educational status: This refers to the number of years spent in formal school in this ways: informal education=1, Primary education=2, Secondary education=3, Tertiary education=4

Occupation: This refers to respondent's major source of income or livelihood. It was measured as a dummy variable with: Part-time farming=1, Full-time farming=2

Farming experience: This refers to the number of years a farmer was engaged in farming. It was measured in the following ways: <5 years, 5-10 years, 11-15 years,16-20 years, 21-25 years, 26-30 years, 31-40 years, >40 years

Farm size: This refers to the total area of farmland available for farming. It was measured in these categories: <1 ha, 1-3ha, 4-6ha, 7-9ha, 10-12ha, >12ha

Farm source: This refers to how the farmer acquired the farmland being used for farming. This was determine by: Purchased=0, Inheritance =1, Government=2, Borrowed=3, Rent=4

Level of income: This refers to the amount of money (in naira) realized from the sale of farm output per annum. It was measured in the following ways: <#10,000, #10,000-#15,000, #16,000-#20,000, #21,000-#25,000, #26,000-#30,000, #31,000-#35,000, #36,000- #40,000, >#40,000

Frequency of contact with Extension Agents: This refers to the number of visits made by the extension agents to farmer's farm. It was measured in the following ways: no visit=0, once per month=1, twice per month=2, trice per month=3, more than trice per month=4

Information Communication Technology (ICT)

Awareness of ICTs: Farmers' awareness of ICTs was determined using two parameters as follows: Aware =1, Unaware =0

Duration of ICT experience: Farmers' knowledge of the duration of ICT experience was measured in the following categories: < 6 years, 6-10 years, 11-15 years, 16-20 years, 21-25 years, 26-30 years, >30 years

Types of ICT facilities: This refers to the types of ICT facilities available to the farmers. This was determined by: Mobile

phone, Computers, Internet, Radio, Television, Camera, E-mail, Scanner, Search engines, DVD, Fax, Printer, Satellite, Videos, CD-ROM, The Website

Sources of ICT facilities: This refers to the provider of the facilities to the farmers. This was measured using: Friend, Government, Purchased, Rent, Community, Business centers, Village Extension Agents

Constraints Associated with ICT: This refers to the problems encountered by the farmers with the use of ICT facilities. This was determined using the following: Erratic network coverage, Lack of power supply, High cost of service, Lack of education, Poor access to extension services, Inconsistence Government Policies, Lack of knowledge of the ICT facilities

Method of Data Analysis

Descriptive statistics (frequencies, percentages and mean) and inferential statistics (Regression analysis) were used to analyze the data.

Model Specification:

The model used for the study was Regression Analysis.

Regression Analysis was used to test the Hypothesis (Ho): there is no significant relationship between socio-economic characteristics and the use of ICT. The results of the analysis obtained will show the assessment of socio-economic characteristics on the use of ICT.

$$Y = a+b_1x_1+b_2x_2+b_3x_3+b_4x_4+b_5x_5+b_6x_6+b_7x_7+b_8x_8+b_9x_9+b_{10}x_{10}+U$$

Where: Y = Use of ICTs

X_1 = Age of the farmer (in years)

X_2 = Sex of the farmer. Using dummy variable, male = 1, female = 2)

X_3 = Marital status. Using dummy variable, singled = 0, married = 1, divorced = 3, widowed = 4.

X_4 = Household size (in number)

X_5 = Educational status (number of years in school)

X_6 = Annual income (in naira)

X_7 = Occupation. Using dummy variable, part-time farming= 1, full-time farming = 2

X_8 = Farm size (in hectares)

X_9 = Farming experience (in years)

X_{10} = Extension contact (number of visits)

$b_1 - b_{10}$ = Regression Coefficients of the variables

a = Constant

U = Unexplained variables (Olayemi, 1998)

RESULTS

Respondents' Socioeconomic Characteristics

Table 1: Distribution of Respondents based on their Socioeconomic Characteristics (90)

Variable	Frequency	Percentage	Mean
Age (years)			
20-30	4	4	
31-40	6	7	
41-50	26	29	
51-60	25	28	54 years
61-70	23	26	
71-80	4	4	
81-90	2	2	
Sex			
Male	81	90	
Female	9	10	
Marital status			
Married	78	86.7	
Divorce	3	3.3	
Widow	6	6.7	
Single	3	3.3	
Household size (persons)			
1-10	58	64	
11-20	22	25	
21-30	7	8	11 persons
31-40	3	3	
Educational status			
____	40	44.4	
____	11	12.2	
____	32	36.6	
____	7	7.8	
Occupation			
Full-Time farming	71	78.9	
Part-Time farming	19	21.1	
Farm size(hectares)			
1-5	80	89	
6-10	6	7	

Source: Field survey, 2021.

ICTs Awareness and Types of ICTs Commonly Used

Table 2: Distribution of Respondents Awareness and Types of ICTs Used *Multiple responses

Variable	Frequency	Percentage	Mean
Awareness			
Aware	75	83	
Not aware	25	17	
Types of ICTs Commonly Used			
Radio	37	36.28	
Television	16	15.69	
Mobile phone	27	26.47	
Camera	2	1.96	
Video	7	6.86	
Email	1	0.98	
DVD	12	11.77	
	*102		

Source: Field survey, 2021

Information obtained using ICT

Table 3: Distribution of Respondents based on the Information obtained by using ICTs

Variable	Frequency	Percentage	Mean
Information			
New innovation	12	18	
Agricultural programmes	10	15	
Farmers' programmes	6	9	
Climate change	2	3	
Personal information	25	37	
Extension visit	1	2	
Farming techniques	3	4	
Planting and harvesting techniques	1	2	
Improved technology	2	3	
Pesticides and application	1	2	
Dry season farming	1	2	
Herbicides application	1	2	
Post- harvest Techniques	3	4	

Source: Field survey, 2021.

Respondents Sources of ICTs

Table 4: Distribution of Respondents' Source of ICTs (n=90)

Variable	Frequency	Percentage	Mean
Source			
Personal	78	87	
Government	2	2	
Business center	9	10	
Extension Agent	1	1	

Source: Field survey, 2021.

Constraints to the Used of ICTs

Table 5: Distribution of Respondents' Constraints to the used of ICTs (n=90)
***Multiple responses**

Variable	Frequency	Percentage	Mean
Constraint			
Erratic network coverage	12	9	
Poor network service	10	8	
High cost of service	6	5	
Poor unstable power	17	13	
Lack of education	8	6	
Government policies	8	6	
ICT illiteracy	34	26	
Poor access to Extension service	35	27	
	*130		

Source: Field survey, 2021

Regression Analysis

Table 6: Regression Analysis of Relationship between the Socioeconomic Characteristics of the Respondents and the Use of ICTs

Variables	Regression coefficient	Standard error	t-value	Significant level	F-value
Constant	489	0.253	1.930	0.57	9.350
Age	-0.005	0.003	-1.459	0.149	
Sex	-0.194	0.086	2.255	0.027	
Marital status	-0.010	0.038	-1.568	0.121	
Household size	-0.010	0.005	-0.291	0.772	
Educational status	-0.010	0.005	-0.249	0.804	
Occupation	0.271	0.074	3.636	0.001*	
Farm size	0.062	0.010	-6.051	0.000*	
Farm source	-0.011	0.360	-0.298	0.767	
Farming experience	0.080	0.003	2.581	0.012**	
Extension contact	0.650	0.044	1.473	0.145***	
Annual income	1.626	0.000	-0.407	0.685	

*Significant at1%, **Significant at 5%, ***Significant at 10%

DISCUSSION

Results in Table 1 indicates that the farmers' age ranged between 20 and 90 years with the mean of 54 years. This implies that the respondents in the study area are old and they cannot withstand stress. Also, the application of ICTs is low and production will equally be low. This is because age determine the quality, quantity and application of ICTs to farm work. Musa (2010) opined that physical labour productivities of the farmers depend on their socioeconomic characteristics namely: age, sex and their health status. The Table also reveals that the entire respondents were male. This implies that men dominate women in terms of farming activities in the study area. This is because farming is a laborious activity that could be handled more effectively by men and more aware of ICTs. It further implies that technology development and transfer will be gender bias (Salau and Saingbe, 2008).

The results in Table 1 indicates that 86.7% of the respondents were married. This indicates the value of married in the study area. This will ensures increase in the family size which in turn provides more hands in the farming activities. Married people are involved in farming activities and more aware about ICTs in order to adopt and improve on production. This implies that most of the arable crop farmers are married. The Table further reveals that 64% of the respondents had a household size within the range of 1-10 persons, and 25% within the range of 11-20 persons with the mean household size of 11 persons. This might affect the ability to purchase ICT devices. Ogunbameru *et al*. (2008) found a significant relationship between household size, farm labour and investment.

Results in Table 1 shows that 36.6% had secondary education and 12.2% had primary education. This implies that most of the farmers in the study area were educated as such would be able to take full advantage of opportunities in the modern day agricultural practices especially in the application of ICTs. This goes contrary to Omotayo (2005), who opined that most Nigerian farmers are illiterates, hence they have no knowledge of the use of ICT facilities like computer and internet.

The results in Table 1 indicates that 78.9% were full-time farmers. This implies that the respondents engaged in farming to meet up with family food security. ICTs have helped smallholder farmers to adopt new technologies including new varieties and also to access market and other important information (Adekoya and Tologbouse, 2005).

The results in Table 1 reveals that majority (89%) cultivates about 1-5ha and 7% cultivates 6-10ha with the mean farm size of 3ha. This implies that majority of the farmers in study area are small scale farmers with small and fragmented farm holdings transferred from generations to generations. This will limit the application of ICTs in their farming activities and produce only for family consumption. This in line with the findings of Musa (2010) that most farmers in Nigeria still produce at a subsistence level. The Table also, shows that 70% of the respondents in the study area exercise control over their farmland by virtue of

inheritance. This implies that there will be no improvements on agricultural output using innovations and application of ICT since the farmlands were fragmented and transferred continuously from generations to generations by inheritance. According to Musa (2010), farm size is an important determinant in the allocation of resources which will eventually impact on the final output and returns.

The results in Table 1 indicates that the experience of the farmers ranged from 1-80 years with mean of 25 years farming experience. The implication of this result was that the farmers were conversant with their farming activities and better able to determine the right ICTs to use to improve their production and welfare. Nwosu (2004) reported that farmers would always count on their experience in allocating their resources in production.

Table 1 shows that 57% of the respondents had no contact with the extension agents while 25.6% had contact once a month and 16.7% had contact twice a month. This implies that most of respondents had no contact with the extension agents. Hence, their level of production will be low since better way of farming were introduced with use of ICTs and the extension agents that will disseminate the information. Steinem *et al.*, (2007) indicated that extension workers use ICTs to gather, retrieve, adapt, localize and disseminate a broad range of information needed by rural families.

Results in Table 1 reveals that 59% of the respondents in the study area had #51,000 - #100,000 and 13% had #101,000 - #200,000 with a mean of #91,727:00k. The implication of this result was that the respondents will find it difficult to cope with farm and family expenses. This in a long-run will not allow the respondents to invest in ICTs. These days it is often said there can be no development without access to ICTs. It is certainly true that farmers with access to new farming technologies farmed better (Spore, 2004).

Table 2 shows that 83% of the respondents were aware of ICTs. This implies that most of the respondents were using one form of ICTs and the other in the study area. Ani (2007) recognized awareness as the first stage in adoption process. The Table further revealed that the respondents were using radio, television, mobile phone, camera, video, email and DVD. The most ICTs used are radio 36.28%, mobile phone 26.47%, television 15.69% and video 6.86%. This implies that the respondents were using the ICTs to listen and watch programs at the same time sent and received some messages. The respondents were not aware of web publishing and internet. According to Omotayo (2005), many rural areas of developing countries had no basic telecommunication services that support key ICTs like the telephone and internet.

Table 3 indicates that (37%) personal information, (18%) new innovations, (15%) agricultural programs and (9%) farmers programs were the most information obtained by using ICTs in the study area. This implies that the respondents in the study area were mostly using the ICTs for personal use. This was attributed to the facts that at the respondents were not sensitized on the use of ICTs to

obtained new technologies of farm production by the extension agents. Steinem *et al.*, (2007) indicated that extension workers use ICTs to gather, retrieve, adapt, localize and disseminate a broad range of information needed by rural families.

Table 4 shows that (87%) personal, (10%) business center, (2%) government and (1%). This implies that the respondents' source of ICTs was personal and as such they made use of it mostly for personal use. This will reduce the use of ICTs for agricultural programs that will improve agricultural activities in the area. According to Omotayo (2005), most Nigerian farmers are illiterates, hence they have no knowledge of the use of ICT facilities like computer and internet.

Table 5 reveals that less than half of the respondents had poor access to extension services and ICT illiteracy, poor unstable power supply and erratic network coverage were the most constraints encountered by the respondents in the study area. This implies that extension agents have a vital role to play in sensitization and dissemination of ICTs knowledge and uses. Steinem *et al.*, (2007) indicated that extension workers use ICTs to gather, retrieve, adapt, localize and disseminate a broad range of information needed by rural families.

Table 6 shows the regression analysis of the relationship between the socioeconomic characteristics of the respondents and the use of ICTs. Among the socioeconomic characteristics variables considered, occupation and farm size reveals a significant ($p<0.01$). Much empirical adoption studies focus on farm size as the first and probably the most important determinant (Dauda, 2005). Also, farming experience shows a significant ($p<0.05$) relationship with the use of ICTs. This is because as the number of years in farming increases there is the need to search for new knowledge to improve the production. This finding supports Adekoya and Tologbouse (2005) who found years of farming experience significantly associated with adoption of agricultural technologies among farmers of Kama district in Eastern Nigeria. The results further shows that extension contact shows a significant ($p<0.10$) relationship with the use of ICTs. This is because as the respondents are having more contact with extension agents there is every tendency for the respondents to use ICTs in their farming activities in order to know the new technology to improve their production and welfare.

CONCLUSION AND RECOMMENDATIONS

The findings reveals that the respondents were old, married with mean household size of 11 persons and educated. The respondents were aware of ICTs and the types commonly used were limited to mobile phones, radio, television and video. The types of information received and sent were limited to personal. The constraints limiting the use of ICTs includes: poor access to extension agents, poor network service, unstable power supply and poor knowledge of ICTs. The results of regression show that occupation, farm size,

years of farming experience and extension contact were significant.

The recommendations are: There is need to enhance ICT infrastructural development and promote ICT education and training of the farmers. Also, extension agents should be readily available to farmers to sensitized and enlighten them on the use and important of ICTs to modern days agriculture.

REFERENCES

Abubakar, L. and Abdullahi, H. (2009). Information and Communication Technologies in Agricultural Development in Nigeria: Challenges and Opportunities. Proceedings of the 43rd Annual Conference of the Agricultural Society of Nigeria, Nov. 25-26, Abuja, pp: 715-717.

Adekoya, A.E. and Tologbouse, E.B.(2005). Adoption and Diffusion of Innovation In: Conference of Nigerian Association of Agricultural Extension, pp. 28-37.

Ani, A.O. (2007), Agricultural Extension: A Pathway for Sustainable Agricultural Development.1st edition, Kaduna: Apani Publication, Pp 179.

Balaji, V., Meera, S. N. and Dixit, X. (2007). ICT-Enabled Knowledge Sharing in Support of Extension: Addressing the Agrarian Challenges of the Developing World Threatened by Climate Change, with a Case Study of India. *SAT eJournal 4 1, 18.*

CTA Spore (2004). "Information and Communication Technology, Information for Agricultural Development in ACP Countries" Proceedings of CTA Observatory on ICTs, Wageningen, pp12.

Daudu, S., Igbashal, A., Ejigonoja, A. (2005). Adoption of Innovation in Soybean Production Among Farmers in Benue State. *Journal of Science and Technology for Development*. I.2, 7-15.

Musa, I.B. (2010). The effects of Formal and Informal Sources of Agricultural Credit on yield and Income of Farmers in Zamfara state. Unpublished M.Sc. Dissertation, Department of Agricultural Economics and Extension, Usmanu Danfodiyo University, Sokoto. Pp 75.

National Population Commission (NPC), Abuja (2006).

Niger State Bureau of Statistics (2017)

Nwosu, I. (2004). Digital Public relations concept and practice in Nwokocha, J . (Ed). *Digital public relations: New techniques in reputation management*. Lagos: Zoom Lens Publishers, pp. 33-38.

Ogunbameru, B.O., Undiandeye, U.C. and Oni, A.O. (2008). Factors Affecting Adoption of Agricultural Technology in Agricultural Extension Methodologies. Apani Publications in Association with Loud Books Publishers, pp 37-41.

Omotayo, O.M. (2005). ICT and Agricultural Extension. In S, F. Adedoyin (Ed). Op. Cit. pp145-157.

Salau E.S. and Saingbe N.D. (2008). Access and Utilization of Information and Communication Technologies (ICTs) Among

Agricultural Researchers and Extension Workers in Selected Institutions in Nasarawa State of Nigeria. PAT 2008; 4(2): 1-11. www.patnsukjournal.com/current issue. Retrieved on 23rd January, 2011.

Shah, P. (2009).Operationalizing ICT in the Rural Space. Available at: http://web/worldbank.org.

Singh, S. (2006). Selected Success Stories on Agricultural Information Systems. Asia-Pacific Association of Agricultural Research Institutions. Bankok, Thailand.

Steinem, J., Bruinsma, W., and Neuman, F. (2007). How ICT can make a Difference in Agricultural Livelihoods. *The Commonwealth Ministers Conference Book*.

World Bank (2002). Information and Communication Technologies. World Bank Group Support for the Development of Information Infrastructure. 157.

Faculty of Agriculture, Ibrahim BadamasiBabangida University, Lapai 2022
Lapai International Journal of Agriculture Vol. 3(1) June,2022 pp 732-743
ISSN:2705-2869

EVALUATION OF PERFORMANCE TRAITS AND NUTRIENT DIGESTIBILITY OF BROILER CHICKENS FED MAIZE COB AS SOURCE OF FIBRE AT GRADED LEVEL

Ibrahim. H, and Aliyu, Z.

Department of Animal Production, Faculty of Agriculture, Ibrahim Badamasi Babangida University, Lapai, Niger State, Nigeria.

zahradeen55@gmail.com ihadiza080@gmail.com ***08036101761***

ABSRACT
An eight weeks research was conducted to evaluate the performance characteristics and nutrient digestibility of broiler chickens fed maize cob in graded level to replace maize at different percentage (%) inclusion level. Diet 1 (T1) contained 100% maize as control, diet 2 (T2) contained 25% maize cob inclusion level, diet 3 (T3) contained 50% maize cob, diet 4 (T4) contained 75% maize cob and diet 5 (T5) contained 100% maize cob inclusion level. A feeding trial was conducted using 150 day old broiler chicks and they were allotted into five treatments of three replicates with each replicate containing ten (10) birds in a completely randomized design (CRD). The result showed that there were significant ($p<0.05$) differences in the final body weight, body weight gain, feed intake and feed conversion ratio among the treatments means. The values recorded for final and body weight gain showed that birds fed T2 diet had the highest average values in the parameters as compared to birds on T3, T1 and T5 and the least average values were observed in T4. Birds on T2 diet had the highest feed intake and recorded the best feed conversion ratio across the treatments and the least feed intake was recorded in birds fed T1 which was the control diet. Birds on T4 diet recorded the poorest feed conversion ratio of 3.28. The results of nutrient digestibility generally showed low digestibility of the diet. There were no significant ($p>0.05$) differences in the ash content. There were significant ($p<0.05$) differences in the moisture content, the crude protein, crude fiber, fat and the nitrogen free extract across the diets. Although, from the moisture content, the crude protein and crude fiber, birds on T1 recorded the highest average values in the parameters and the least were recorded in T5 for moisture and crude protein and in T2 for crude fiber. Significant ($p<0.05$) difference was observed in the fat and nitrogen free extract. Higher average values of 4.67% was obtained in both T4 and T5 for fat and the least average value of 5.88% was recorded in T3. Thus it was concluded that birds in T2 (birds fed diet incorporated with 25% of maize cob) had the best growth performance and also recorded the least mortality rate as compared to the control diet in T1 and as such, 25% of maize cob can be incorporated in broilers diet as a replacement for energy source without any negative effect on the birds. It was also concluded that as the level of inclusion increased, the percentage digestibility reduces in most of the parameters measured.

KEYWORDS: Maize cob, Broiler, Nutrient digestibity, Performance, Fibre

Faculty of Agriculture, Ibrahim BadamasiBabangida University, Lapai 2022
Lapai International Journal of Agriculture Vol. 3(1) June,2022 pp 732-743
ISSN:2705-2869

INTRODUCTION

The interest of developing nations in endorsing the production of fast growing animals such as poultry came as a result of increasing demand for animal protein (Obinne and Okorie, 2008). This is ascribed to population growth in these countries. In Nigeria, the difference between production and consumption of animal protein is below the recommended level. This pose threat to food security and may lead to malnutrition (Adesehinwa, 2008). Thus, to avert this trend, several attempts have been made to increase animal production in the country to bridge the gap. Most of the effort was directed towards poultry production. The policy to increase the production of poultry is seen as definite way of bridging the gap between production and intake of animal protein (Adesehinwa, 2008). Atteh (2004) noted that the protein from poultry meat is of high quality and in several cases; it is used as a standard against which other animal proteins are compared. This is because broiler chicken grows very fast and provides tender meat for human consumption.

Several methodologies are adopted to guarantee food security for people worldwide especially the use of farm by-products in livestock production. Malnutrition problems are more prominent in less developed nations (FAO, 2008), and this has always led to resurgence of interest in the sourcing of economical alternative feed ingredients as replacement for the more expensive conventional ones in feed formulation. The impact of this is to increase the availability and affordability of animal products in order to improve global food crisis. The 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 understood that feeding alone accounts for about 60 to 85% of the cost of intensively reared monogastric animals (Sanni and Ogundipe, 2005).In an attempt to increase poultry production, nutritionists have tried to harness and utilize agro-industrial by-products that are not directly utilized by man. A large number of alternative feedstuffs that have potential as poultry feed ingredients in Nigeria is misused in the farms. Adeniyi and Balogun (2002) stated that research into the use of cheaper industrial by-products and wastes have been strengthened in the last few years to determine the efficiency of their utilization in terms of growth and production. The search for cheaper sources of feed ingredients for livestock feeding in Nigeria and many developing countries will continue, as long as protein requirement in human diet has not been met. There are several attempts to reduce the cost of poultry production by replacing some percentage of maize with other agro-industrial by-products such as maize offal, brewers dried grain, wheat offal, cassava peel meal, rice offal. Increasing the level of fiber in poultry feeds may enhance performance (Sklan, *et al.,* 2003).

Faculty of Agriculture, Ibrahim BadamasiBabangida University, Lapai 2022
Lapai International Journal of Agriculture Vol. 3(1) June,2022 pp 732-743
ISSN:2705-2869

MATERIALS AND METHODS

Experimental location

The experiment was conducted at the Poultry Unit of Ibrahim Badamasi Babangida University Teaching and Research Farm, Lapai, Niger State. Lapai lies between latitude 9°02N and longitude 6°34E of the equator (Usman, 2013). The area falls within the Southerppn Guinea Savannah Vegetation Zone of Nigeria with mean rainfall ranges between 1100-1600mm and mean temperature between 21°C and 36.5°C (Usman, 2013).

Source and processing of the test ingredients

Maize was purchased from Lapai market. Wheat offal, groundnut cake (GNC), premix, bone meal, methionine, lysine, fish meal and salt were obtained from Animal care shop Gidanmatasa,Minna, Niger state. Maize cob was sourced from Alhaji Abudulkadir farm in Lapai. The maize cob were cut into smaller pieces, sundried and grind into powder.

Experimental diets

Five experimental diets were formulated. The diets contained the test ingredient in graded level to replace maize at different percentage (%) inclusion level (Tables 1.0 and 2.0).

- Diet 1 (T1) contained 0% of maize cob as controlled.
- Diet 2 (T2) contained 25% maize cob inclusion level.
- Diet 3 (T3) contained 50% maize cob inclusion level.
- Diet 4 (T4) contained 75% maize cob inclusion level.
- Diet 5 (T5) contained 100% maize cob inclusion level.

Table 1: Gross composition of experimental broiler starter dietsp

Ingredients (%)	Treatments				
	T1	T2	T3	T4	T5
Maize	54.00	40.50	27.00	13.50	-
Wheat offal	15.00	15.00	15.00	15.00	15.00
Fish meal	2.00	2.00	2.00	2.00	2.00
GNC	24.07	24.07	24.07	24.07	24.07
Bone meal	2.50	2.50	2.50	2.50	2.50
Limestone	1.00	1.00	1.00	1.00	1.00
Methionine	0.20	0.20	0.20	0.20	0.20
Lysine	0.10	0.10	0.10	0.10	0.10
Vitamin premix	0.25	0.25	0.25	0.25	0.25
salt	0.25	0.25	0.25	0.25	0.25
Maize cob	-	13.50	27.00	40.50	54.00
Total	100.00	100.00	100.00	100.00	100.00
Calculated values					
CP (%)	23.23	23.01	23.24	22.85	22.64
CF (%)	4.16	4.40	4.64	4.88	5.12
ME(Kcal/Kg)	2814.01	2804.97	2813.32	2801.32	2808.22

Key:
GNC= Groundnut cake
CP= Crude protein
CF= Crude fibre
ME= Metabolizable energy
T1: 0% of maize cob was incorporated
T2: 25% of maize cob was incorporated
T3: 50% of maize cob was incorporated
T4: 75% of maize cob was incorporated
T5: 100% of maize cob was incorporated

Table 2: Gross composition of experimental broiler finisher diets

Ingredients (%)	Treatments				
	T1	T2	T3	T4	T5
Maize	48.00	36.00	34.00	12.00	-
Wheat offal	13.00	13.00	13.00	13.00	13.00
Fish meal	3.00	3.00	3.00	3.00	3.00
GNC	31.70	31.70	31.70	31.70	31.70
Bone meal	2.50	2.50	2.50	2.50	2.50
Limestone	1.00	1.00	1.00	1.00	1.00
Methionine	0.20	0.20	0.20	0.20	0.20
Lysine	0.10	0.10	0.10	0.10	0.10
Vitamin premix	0.25	0.25	0.25	0.25	0.25
salt	0.25	0.25	0.25	0.25	0.25
Maize cob	-	12.00	14.00	36.00	48.00
Total	100.00	100.00	100.00	100.00	100.00
Calculated values					
Crude protein (%)	20.15	20.20	20.27	19.80	19.78
Crude fiber (%)	4.15	4.42	4.69	4.96	5.23
ME(kcal/ kg)	2836.88	2810.94	2800.15	2802.16	2802.19

Calculated values

Crude protein (%)	20.15	20.20	20.27	19.80	19.78
Crude fiber (%)	4.15	4.42	4.69	4.96	5.23
ME(kcal/ kg)	2836.88	2810.94	2800.15	2802.16	2802.19

Key:
GNC= Groundnut cake
ME= Metabolizable energy
T1: 0% of maize cob was incorporated
T2: 25% of maize cob was incorporated
T3: 50% of maize cob was incorporated
T4: 75% of maize cob was incorporated
T5: 100% of maize cob was incorporated

Experimental birds and management

A total of one hundred and fifty (150) broiler birds were used for the experiment. The broilers were purchased from a reputable farm at day old. They were allotted into five treatments of three replicates with each replicate containing ten (10) birds. The birds were placed on the experimental diet on their arrival. Prior to the arrival of the birds, all necessary scrubbing, cleaning and disinfecting of the pen with Izal and Dettol was carried out. The pen was prepared and the floor was well littered with fresh wood shaves (the litter material) and covered with newspaper. The chicks were brooded on deep litter using charcoal pot and kerosene lanterns as sources of heat and light respectively. Anti-stress was given immediately they arrived and feed was also served. The birds were vaccinated with Gumboro vaccines at the age of one week, Newcastle disease vaccine (Lasota) at two weeks and Gumboro disease vaccine (booster) at three weeks. Similarly, all the necessary routine management practices were duly observed. The experiment lasted for eight weeks.

Experimental design

A total of 150 birds were randomly allocated to each of the five treatments. Each of the experimental unit had three replicates designated as R1, R2 and R3 with 10 birds each in a completely randomized design.

Table 3: Experimental layout

Replicates	**Treatments**				
	T1	**T2**	**T3**	**T4**	**T5**
R1	T1R1	T2R1	T3R1	T4R1	T5R1
R2	T1R2	T2R2	T3R2	T4R2	T5R2
R3	T1R3	T2R3	T3R3	T4R3	T5R3

Data collection

Performance evaluation

Feed consumption from each treatment was determined on weekly basis by subtracting left-over from served feed given per group. Adequate measures were taken to safeguard against spillage and related wastage. The mean daily feed intake was calculated by dividing the amount consumed by the number of birds in the group.

Experimental birds were weighed individually (weekly) using a weighing balance and the weights recorded. The mean live weight of each treatment group was determined by dividing total weight by the total number in that group.

The body weight gain of each of the treatment group was obtained by calculating the difference between the mean live weights of the current week from the mean live weight of the preceding.

Feed intake = feed offered (g) – left over (g).

Weight gain = final weight(g) – initial weight(g).

$$\textbf{Feed conversion ratio (FCR)} = \frac{\text{feed consumed(g)}}{\text{weight gain (g)}}$$

$$\textbf{Mean daily gain} = \frac{\text{mean final weight gain}}{\text{number of days}}$$

$$\textbf{Mean feed intake} = \frac{\text{feed intake}}{\text{number of days}}$$

$$\textbf{Mortality (\%)} = \frac{\text{number of dead birds}}{\text{initial number of the birds}} \; x\; 100$$

Nutrient digestibility

Three (3) birds (one bird from each replicate) were randomly selected a week prior to the feeding trial. They were caged and allowed for adjustment period of three days. Each bird was offered a known amount of experimental diet. Total fecal samples were collected and weighed daily for five days. They were bulked for each replicate and analyzed for proximate composition using the methods described by AOAC (2005).

Statistical Analysis

Data collected were processed and analyzed using SPPS version 20.0 and means that were significantly different were separated using Duncan's New Multiple Range Test (Duncan, 1955)

RESULTS

The productive performance of broiler chicken fed with diet containing maize cob at graded level as source of energy is presented in Table 4. The results of final weight, body weight gain, feed intake and feed conversion ratio showed significant ($p<0.05$) differences across the diets. The final weight gain of the birds were 1066.70g, 1400.00g, 1233.30g, 1000.00g and 1033.30g for T1, T2, T3, T4 and T5 respectively. Body weight gain was higher in T2 (1361.50g) and the least was recorded in T4 (962.40g). There were significant ($p<0.05$) difference in the feed conversion ratio (FCR). Birds fed 25% maize cob had better ability of converting feed to flesh followed by birds on T3 diet. Birds on T4 recorded the highest (16.66%) mortality while the lowest (3.33%) was in birds fed T2 diet

Table 4: Growth performance of broilers fed test ingredients

Parameters	Treatment						
	T1	T2	T3	T4	T5	SEM	LSD
Initial weight(g)	37.33	38.47	37.87	37.60	37.93	1.23	0.91
Final weight(g)	1066.70^{c}	1400.00^{a}	1233.30^{b}	1000.00^{c}	1033.30^{c}	51.64	0.00
Body weight gain(g)	1029.70^{c}	1361.50^{a}	1195.50^{b}	962.40^{c}	995.40^{c}	51.41	0.00
Feed intake(g)	3016.70^{b}	3263.30^{a}	3110.00^{ab}	3163.30^{ab}	3046.70^{b}	70.26	0.04
Feed conversion ratio	2.95^{ab}	2.39^{c}	2.60^{bc}	3.28^{a}	3.07^{a}	0.17	0.00
Mortality (%)	10.00	3.33	10.00	13.33	16.66	0	0

KEY:
SEM=Standard error of mean
LSD= Least significant difference
Means in the same row with different superscript are significantly different ($p<0.05$), means with the same superscript are not significantly different ($p>0.05$).

Table 5: Nutrient digestibility parameters of broilers fed test ingredients

Parameters (%)	Treatments						
	T1	T2	T3	T4	T5	SEM	LSD
Moisture	6.78[a]	5.87[b]	5.65[b]	5.93[b]	5.57[b]	0.17	0.00
Crude protein	21.69[a]	21.22[b]	20.49[c]	21.66[a]	20.15[d]	0.09	0.00
Crude fiber	12.48[a]	10.33[e]	11.19[d]	11.98[b]	11.68[c]	0.12	0.00
Ash	16.00	15.59	15.63	15.72	15.73	0.21	0.39
Fat	6.30[a]	6.00[b]	5.88[b]	6.47[a]	6.47[a]	0.10	0.01
Nitrogen free extract	36.77[c]	40.97[a]	41.12[a]	38.22[b]	40.39[a]	0.36	0.00

KEY:
SEM=Standard error of mean
LSD= Least significant difference
Means in the same row with different superscript are significantly different ($p<0.05$), means with the same superscript are not significantly different ($p>0.05$).

The effect of replacing maize with graded level of maize cob as source of energy on the nutrient digestibility trial of broiler chickens fed the test ingredient is shown below in table 5.0. There were significant ($p<0.05$) differences in the moisture content, the crude protein, crude fiber, fat and the nitrogen free extract across the diets. Higher values of 6.78%, 21.69%, 12.48% and 16.00% were all obtained in T1 across the diets for moisture, crude protein, crude fiber and ash respectively, while lower values of 5.57% and 20.15% were recorded in T5 for moisture and crude protein and lower values of 10.33% and 15.59% were obtained in T2 for crude fiber and ash respectively. There were no significant ($p>0.05$) difference in the fat content as recorded on the table.

DISCUSSION

Results from Table 4.0 indicated that; there were significant ($p<0.05$) differences in the final body weight, body weight gain, feed intake and feed conversion ratio among the treatments means. The values recorded for final and body weight gain showed that birds fed T2 diet had the highest average values in the parameters as compared to birds on T3, T1 and T5 and the least average values were observed in T4. This implies that, 25% of maize cob can be incorporated

in broiler chickens diet without affecting growth parameters. This result may be that the higher the inclusion of maize cob, the more it affect the growth of the birds negatively. Birds on T4 recorded the lowest final weight gain and body weight gain compared to other treatments. This result is in line with a similar study carried out by Donkoh *et al*., (2003) who reported that diets containing up to 7.5% ground maize cobs fed ad libitum to commercial broiler chickens did not alter growth performance, carcass yields, health and biochemical indices

Birds on T2 diet had the highest feed intake and recorded the best feed conversion ratio across the treatments and the least feed intake was recorded in birds fed T1 which was the control diet. Birds on T4 diet recorded the poorest feed conversion ratio of 3.28. This findings correspond with the submission of Oyebimbe *et al.,* (2006) who reported that high fiber diets usually tend to inhibit protein utilization at high inclusion levels, leading to low feed conversion ratio and body weight gain. The results of nutrient digestibility from Table 5.0 above generally showed low digestibility of the experimental diet. There was no significant ($p>0.05$) differences in the ash content although the highest value of 16.00% was obtained in T1 whereas the least value of 15.59% was obtained in T2. This indicates that replacing maize with varied level of maize cob does not have any negative effect based on the ash content. There were significant ($p<0.05$) differences in the values of the moisture content, crude protein, crude fiber, fat and the nitrogen free extract across the diets. Higher value of moisture, crude protein and crude fiber, were recorded on T1 while least values were recorded in T5 for moisture and crude protein, lowest percentage of crude fibre was recorded in T2. Significant ($p<0.05$) variation was observed in the values of fat and nitrogen free extract. Higher average values of 4.67% were recorded in both T4 and T5 for fat and the least average value of 5.88% was recorded in T3. The result also showed that as the level of inclusion increased, the percentage digestibility of the nutrients decreases. This agreed with the findings of Abeke (2008) that monogastric animals unlike ruminants do not have the necessary enzymes for degrading cellulose.

CONCLUSION

From this research work, it was concluded that birds in T2 (birds fed diet incorporated with 25% of maize cob) had the best growth performance and also recorded the least mortality rate as compared to the control diet in T1 and as such, 25% of maize cob can be incorporated in broilers diet as a replacement for energy source without any negative effect on the birds. It was also concluded that as the level of inclusion increased, the percentage digestibility reduces in most of the parameters measured

REFERENCE

Abeke,F. O., Ogundipe, S. O., Dafwang, I. I., Sekoni, A. A., Abu, A. and Adeyinka, I. A. (2008). Effect duration of cooking of some anti-nutritional factors of nine varies of Lablab purpureus beans. Nigeria Journal of Animal production. 35 (2); 217-223.

Adeniyi, A.A. and Balogun, O.O. (2002). Utilization of flavour treated blood-rumen content mixture in the diets of laying hens. *Nigerian Journal of Animal Production.* 29(1): pp34-39.

Adesehinwa A.O.K., (2008). Energy and protein requirements of pigs and the utilization of fibrous feedstuffs in Nigeria. *African Journal Of Biotechnology725(25):4798-4806*

Atteh, J. O. (2004). Theory and practice of poultry production (1st ed., pp. 1–3). Ilorin: Adlek Printers.

Donkoh, A. ; Nyannor, E. K. D. ; Asafu-Adjaye, A. ; Duah, J., (2003). Ground maize cob as a dietary ingredient for broiler chickens in the tropics. J. Anim. Feed Sci., 12 (1): 153-161

Duncan, D. B. (1955). New Duncans Multiple Range and Multiple F-test. Biometrics 11:1-42.

Evers, A. D.; Kent, N. L., (1994). Kent's technology of cereals: an introduction for students of food science and agriculture. Woodhead Pub. Series Food Sci., Technol. Nutr., Elsevier

FAO(2008).Food and Agricultural Organization of the United Nations Online statistical database, Rome, Italy. www.fao.org

Obinne, J.I.andOkorie, A.U. (2008).Effect of different crude protein and digestible energy levels on the growth performance of rabbits inthe tropics.*Nigeria Journal Animal Production, 35, 210-216*

Oyebimpe, K., Fanimo, A.O," Oduguwa, O.O and Biobaku, W.O. (2006). Response of broiler chickens to cassava peel and maize offal in cashew nut meal-based diets. *Archivos de Zootecnia* 55: 301-304

Sanni S.A. and ogundipe S.O.(2005). Some modules of poultry production inKaduna State, Nigeria. Nigerian Journal of Animal Production32(1):102-107

Sklan, D., A. Smirnov, and I. Plavnik. (2003). The effect of dietary fiber on the small intestines and apparent digestion in the turkey. Br. Poult. Sci. 44:735-740.

Faculty of Agriculture, Ibrahim BadamasiBabangida University, Lapai 2022
Lapai International Journal of Agriculture Vol. 3(1) June,2022 pp 744-758
ISSN:2705-2869

PROFITABILITY AND TECHNICAL EFFICIENCY OF LOWLAND RICE FARMING IN NIGER STATE, NORTH CENTRAL NIGERIA

Lawal, A. F[1], Bwala*, M. A[1], Gudugi, I. A. S[2], Paiko, A. M[3], Sule, B. A[1], Abdullahi, M. B[1], Ubandoma, A[1] & Yahaya G[2].

[1]Department of Agricultural Economics and Extension services, Faculty of Agriculture, Ibrahim Badamasi Babangida University Lapai, Nigeria
[2]Department of Crop Production, Faculty of Agriculture, Ibrahim Badamasi Babangida University Lapai, Nigeria
[3]Department of Biochemistry, Faculty of Natural Science, Ibrahim Badamasi Babangida University Lapai, Nigeria

* Author for correspondence: madubwala@gmail.com

ABSTRACT

This study determined the profitability of lowland rice production system in Niger State, North-central Nigeria. Primary data were obtained from a sample of 502 respondents obtained through a multi-stage random sampling technique. Cost Benefit Analysis (CBA) was used to estimate the profitability of the production system, while the stochastic frontier analysis was used to estimate the efficiency levels of the farmers in the study area. The results of the CBA analysis revealed that lowland rice production in Niger State is profitable venture and that farmers will break even with a 39% fall in yield. The mean technical efficiency was 41%. Farm size, seed ($p < 0.01$) and herbicide ($p<0.05$.) were the inputs significantly affecting technical efficiency while the significant inefficiency factors were age and gender of the respondent. The study therefore recommends a sustained focus on improved production practices of paddy to increase profitability through improved productivity of resources.. Having observed that the major constraint facing the farmers is inadequate fund, there is dire need for both private and Government agencies to collaborate to provide loan to the farmers increased production of paddy in the study area.

Keywords: lowland Paddy, technical efficiency, profitability, Stochastic frontier, resource allocation

INTRODUCTION

Rice is one of the major staple foods consumed by most people in Sub-Saharan Africa. There are about 23 species of rice out of which African rice (*Oryza glaberrima*) and Asian rice (*Oryza sativa*) are the two known species with commercial value (Subedi *et al*., 2020). In Nigeria, rice is one of the fastest-growing food commodities with a likelihood of continuous growth. The apparent increase in demand for rice is associated with the rapid population growth, urbanization, and consumer preference for rice as a convenience food (Obianefo *et al.*, 2019; United States Department of Agriculture (USDA), 2014). There is a shortfall between the demand and supply for rice in Nigeria. Thus, attainment of self-sufficiency in rice production is yet to be achieved (Obianefo *et al*., 2020). Niger State is one of the major rice producing states in the country. Over the years, it has remained one of the leading contributors to Nigeria's agricultural productivity. The State has an ecological advantage in rice production over other states in the country. This is because it is endowed with broad valley bottoms or 'fadama' (lowlands) and flood plains which are normally found along the Rivers Niger and Benue troughs. Several studies have been carried out to assess the profitability of rice production in Nigeria (Lawal *et al.,* 2014; Ohen and Ajah, 2015; Oyedepo and Adekanmbi, 2018, and Gona and Danmaigoro, 2019). Studies by Nigerian Institute of Social and Economic Research (NISER) (2001) on price and trade incentives on Nigerian crops, livestock, fisheries, and forestry, affirmed the profitability of rice production in various parts of the country. The study attributed variations in profitability to differences in rice production systems. Ohen and Ajah (2015) observed that though small-scale rice production is profitable, it was essential to implement sustainable strategies aimed at protecting local producers. Over the years, successive governments have intervened via introduction of policies and programmes targeted at increasing local production of rice aimed to address the shortfall situation in the country (Badawi, 2004; Adewuyi and Amurtiya, 2021). Despite these policies, farmers would only be willing to go into paddy production when they consider the venture to have good return.

About 90% of farm lands in Nigeria are rain-fed lowlands (Ugalahi *et al*., 2016; Ayedun and Adeniyi, 2019). It is the most predominant rice production environment and accounts for over 50% of the total rice produced in Nigeria. Rice production in Nigeria is predominantly done by small-scale farmers who do not quantify their production efficiency (Bitrus et al., 2021). Low productivity in rice production resulting from efficiency loss in production has been identified as a major challenge facing rice producers (International Food Policy Research Institute IFPRI, (2016). According to de Wit (1992), strategic research should be directed towards the

search for the minimum of each production resource that is needed to allow maximum utilization of all other resources and not towards the search for marginal returns of variable resources. This is particularly relevant in developing countries like Nigeria where there is persistence of large yield gaps between rice supply and demand. Farmer's efficient utilization of resources is essential to increasing production which in turn contributes to economic growth (Adewuyi and Amurtiya, 2021). Consequently, this study assessed the profitability of lowland rice production system and determined the technical efficiency level among paddy farmers in Niger State, Nigeria.

MATERIALS AND METHODOLOGY

Sampling Procedure

The study was conducted in Niger State, north central Nigeria. Sample for the study was obtained using multistage simple random sampling technique. Primary data was obtained from 502 randomly selected rice farmers using pre-tested structured interview schedule. The survey was carried out over a period of two months (from May 2020 to June 2020). Paddy production data collected include quantity of seed planted, type and quantity of labour used, quantity of fertilizer and pesticide applied, and quantity of paddy harvested.

Analytical Technique

A combination of analytical techniques were used for the study. Cost Benefit Analysis (CBA) was utilized to estimate the costs, returns and profitability ratios of the farmers. While the stochastic frontier model was used for the efficiency analysis

Benefit cost ratio (BCR)

The BCR is a profitability ratio that measures the relationship between the cost and benefit of a farm project or investment (Swiss Agency for Development and Cooperation (SDC), 2015). It is the major output of a CBA. A BCR value that is greater than one implies the project or investment has a positive net present value hence the higher the value of the BCR, the more profitable the project. The BCR is expressed as:

$$BCR = \frac{TR}{TC} \quad (1)$$

Where BCR = Benefit Cost Ratio,
TR = Total Revenue and TC = Total Cost

Net farm income (NFI)

Net farm income (NFI) is the difference between gross income and total costs of production. It is the income generated from the enterprise, which can be drawn without affecting the future rate of production. It measures returns to unpaid factor inputs such as farmers' management input. The NFI is specified in equation 2.

$$NFI = \sum_{j=1}^{m} P_j Q_j - \sum_{k=1}^{m} P_k Q_k - \sum_{i=1}^{1} FL \quad (2)$$

Where: NFI = Net Farm Income; P_j= price of a unit of j^{th} output; Qj = quantity of j^{th} output; P_k = price of a unit of k^{th} input; Q_k = quantity of k^{th} input; FL = cost of fixed inputs; and $\sum$ = summation sign.

Rate of return on investment (RRI)

Total revenue must be greater than cost of production for an investment to be worthwhile. The rate of return on investment is the net gain or loss of an investment over a period expressed as a percent of the initial cost of the investment. Therefore, the greater the RRI, the better the investment. RRI is expressed as:

$$RRI = \frac{NFI}{TC} \times 100 \quad (3)$$

Where: NFI = Net Farm Income and TC = Total Cost of production

Breakeven analysis

The Breakeven analysis is a tool for calculating that point in the sale of a product, where neither profit nor loss is incurred. The breakeven point is therefore an indicator of the financial viability of an enterprise. Switching value is useful in risk analysis. The switching value of a variable is the percentage by which the variable would have to change to break even (Food and Agriculture Organisation (FAO), 2000. To estimate the breakeven output, equation 4 was used:

$$Breakeven\ output = \frac{(TC \times QO)}{TR} \quad (4)$$

Where: TC= Total Cost, QO = Quantity of Output, and TR = Total Revenue.

Stochastic Production Frontier Model

Technical efficiency is measured as the ratio between the observed output and the maximum output, under the assumption of fixed input, or, alternatively, as the ratio between the observed input and the minimum input under the assumption of fixed output (Porcelli, 2009). The stochastic frontier analysis (SFA) is a widely used technique in estimating production efficiency levels. It uses a parametric approach and is commonly used in estimation of the technical efficiency of the farm with multiple inputs and one output (Boundeth *et al*., 2012). The stochastic frontier approach incorporates the random error of regression that captures the effect of insignificant residual variables and errors of dependent variables as well as the farm specific inefficiencies. Stochastic frontier model tends to separate technical inefficiency from noise by incorporating two error terms. The first error component, also called a statistical noise, accounts for random effects. The second component represents systematic effects that are not

explained by the production function but are attributed to technical inefficiency that is, reflecting measurement error or shocks beyond the control of the farmer. The production frontier model derived from the composed error model of Aigner *et al.,* (1977), Meeusen and Van den Broeck (1977) and Forsund *et al.,* (1980) as used by Rahji,(2005), Lawal *et al*., (2014) was adopted for this study.

The empirical stochastic frontier production function model is specified thus:

$$\ln Y = b_0 + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + b_4 \ln X_4 + b_5 \ln X_5 + (V_I - U_i) \quad (1)$$

Where: ln = natural logarithm, Y = rice output in kg/ha, b_0, b_1, b_2,b_3, b_4 and b_5 = parameters estimated, X_1 = farmland (ha), X_2 = labour (man-days), X_3 = rice seed (kg), X_4 = fertilizer (kg), X_5 = herbicide (liter), V_i = random variables presumed to be independent of U_i, U_i = non-negative random variables presumed to account for technical inefficiency in production.The inefficiency of production, $U_i$was expressed in terms of the factors that are presumed to affect the farmer's production efficiency. These factors are associated with the socio-economic variables of the farmers. The determinant of technical inefficiency is expressed as:

$$\mu = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 \quad (2)$$

Where: μ = Technical inefficiency, δ_0 = constant, $\delta_1 - \delta_4$ = parameters estimated, Z_1 = age (years), Z_2 = Gender, Z_3 = Marital status, Z_4 = education (years spent in formal education), δ_0= constant, δ_1- δ_4 = parameters estimated.

This work used single stage model to estimate the parameters of the stochastic frontier function model using STATA.

RESULTS AND DISCUSSION

Profitability of Rice Farming

The cost and return analysis of rice farmers in the study area is presented in Table 1. The analysis was carried out using mean values of inputs used and output obtained from the production system. The variable costs estimated include land, seed, and labor. Other inputs include pesticide, fertilizer, and herbicide. The total variable inputs were estimated to be one hundred and forty thousand, sixteen (N140,016.00) naira only. The fixed items include hoe, sprayer, axe, rake, and sickle/cutlass. The total fix cost was estimated at ₦5,088.45/ha. This is about 3.5% of total cost of production. The gross margin was estimated as ₦235,769.00/ha at an average yield of 44.21bags (2,210.5kg)/ha while the net farm income (NFI) was ₦230,680.55/ha. A positive value of the NFI is an indication that lowland rice production is profitable. The degree of profitability was estimated using the BCR and the RRI.

Table 1.Average cost and returns for rice producers per hectare.

Variable Cost	Quantity	Price	Useful life	Depreciation	Value (₦)
Total Revenue	44.21 (2,210.5 Kg)	8500.00			375,785.00
Variable cost					
Land	1.3			-	48,398.61
Seed	66.5	196.92		-	13,095.26
Labor	41	1000.00		-	41,000.00
Pesticide	1	911.43		-	911.43
Fertilizer	5	5827.73		-	29,138.65
Herbicide	5	1494.41		-	7,472.05
Total Variable Cost					140,016.00
Fixed Cost					
Cutlass/sickle	5	589.74	4	97.95	489.75
Hoe	3	2,019.00	4	383.8	1,151.4
Sprayer	1	17,821.07	8	3,164.21	3,164.21
Axe	1	1,145.13	4	189.03	189.03
Rake	1	620.28	4	94.06	94.06
Total Fixed Cost				3,929.04	5,088.45
Total Cost					145,104.45
Gross Margin		235,769.00			
Net Farm Income		230,680.55			
BCR		2.59			
RRI		159%			
SWITCHING VALUE =		17.1			

Source: Field survey, 2020

The BCR for the production system was estimated as 2.59. This implies benefits are 2.59 times the costs of production, indicating profitability. This is confirmed by the value of the rate of return on investment which is also 159%. The break-even output for paddy yield is 17.1bag (855kg). This implies paddy yield will have to fall by more than 39% for the farmers not to break even.

Technical efficiency of farmers

The levels of technical efficiency achieved by rice farmers in the study area are presented in Table 2. The average efficiency level among the farmers is 41%, furthermore, results show that the farmers in the study area are operating below 50% level of efficiency. However, about 48.4% of the farmers are operating within the efficiency level of 30.89 – 40.25% while 43% of them are operating between the efficiency level of 40.26 and 40.62. This is a clear indication that farmers in the study area are making inefficient use of resources. However, they can greatly increase their efficiencies by adopting improved technology and farming practices to enable them to attain higher technical efficiencies. Farmers having efficiency levels less than 50% is not uncommon in Nigeria. Oladimeji and Abdulsalam (2013) also reported about 40% of rice farmers in Kwara State have technical efficiencies below 45%. However, Bwala et. al., 2015 reported an efficiency range of 0.91-0.98 for rice farmers in North Central Nigeria.

Table 2: Technical Efficiency Scores for Rice Farmers in Niger State

Efficiency score	Frequency	Percent
<= 30.50	2	0.4
	31	5.2
30.89 – 40.25	290	48.4
40.26 – 40.62	258	43.0
40.63 – 50.01	18	3.0
Total	600	100

Source: Base Line Survey, 2020

Determinants of Technical Efficiency

The stochastic production frontier results as presented in Table 3 show that farm size and seed variables are significant at 1 percent level. Herbicide variable on the other hand was significant at 5% level of significance. The results however indicated that the fertilizer variable was not significant. The signs of the significant variables indicate a positive relationship with the dependent variable. This implies that increase in farm land, seed and use of herbicide would increase farm output in the study area.

Table 3: Stochastic Frontier Production Function of paddy Producers in Niger State

Variables	Coefficients	Standard Error	Z	P>z	95% Confidence Interval	
Land	0.282	0.027	10.60	0.000	0.2297	0.3340
Labour	0.028	0.063	0.44	0.660	-0.0962	0.152
Seed	0.222	0.029	7.61	0.000	0.1649	0.279
Fertilizer	-0.008	0.008	-1.00	0.319	-0.0248	0.008
Herbicides	0.039	0.011	3.37	0.001	0.0165	0.063
Constant	3.819	0.226	16.88	0.000	3.3761	4.262
lnsig2v						
Constant	-3.141	0.179	-17.43	0.000	-3.464	-2.763
lnsig2u						
Land	0.174	0.157	1.11	0.268	-0.133	0.481
Labour	0.421	0.402	1.05	0.295	-0.366	1.207
Seed	0.364	0.145	2.51	0.012	0.079	0.649
Fertilizer	-0.291	0.042	-6.93	0.000	-0.372	- 0.208
Herbicides	-0.152	0.058	-2.64	0.008	-0.265	- 0.038
Age	-0.027	0.010	-2.61	0.009	-0.046	- 0.006
Gender	-0.539	0.239	-2.25	0.024	-1.008	- 0.070
Marriage	-0.027	0.162	-0.17	0.867	-0.345	0.290
Education	-0.147	0.084	-1.740	-0.313	0.019	
Constant	-0.948	1.615	-0.59	0.557	-4.11	2.217
Sigma v	0.211	0.018			0.177	0.251
Log likelihood	-174.894					
Prob> chi2	0.000					
Wald chi2	244.60					

Source: Field survey, 2020

The explanatory variables for the technical inefficiency with respect to inputs show seed have a positive relationship with the inefficiency variable. This means that seeds planted are not efficiently allocated with respect to land ratio. This can be explained by the fact that most of the farmers broadcast the rice seeds, and they do so not sparingly which may lead to over seeding. The results further indicate that fertilizer and herbicide variables have a negative relationship with inefficiency. This means that the application of the two inputs by the famers is still within the threshold of efficiency. The trend of inefficiency in the allocation of resources among the farmers may be an indication that the expected benefits from the cultivation of rice are not fully realized by the farmers in the study area. The generalized likelihood ratio estimated at -174/89 is significant at 0.01 level; this suggests the presence of one-sided error component and significant technical inefficiency in the production function. Thus, estimation of the regression equation using a classical ordinary least square model would be inadequate representation of the data. This confirms the relevance of stochastic parametric production frontier and maximum likelihood estimator for the data generated from this study.

For the socioeconomic factors explaining the inefficiency on the farms, age and gender of the farmer have a negative relationship with the inefficiency variable. By implication, farmer age and gender decrease the inefficiency on the rice farms in the study area. In other words, older farmers are more efficient than young farmers. This may be related to the fact that the older the farmer gets, the more experience he acquires and by implication the better they become in utilizing productive resources. Also, gender plays a role in the inefficiency level obtainable on the farm. The results imply that male farmers are more efficient than their female counterpart. This may be attributed to the fact that the male farmers have all the time and freedom to plan and carry out activities on their farms without much encumbrances as encountered by the female gender. Female farmers usually must contend with family chores which may take up most of their time away from farming activities.

Technical efficiency of farmers

The levels of technical efficiency achieved by rice farmers in the study area are presented in Table 4. The results show that all the farmers in the study area are operating below 50% level of efficiency. The average efficiency level for the farmers in the study area is 41%, about 48.4% of farmers are operating within the efficiency level of 30.89 – 40.25 while 43% of are operating between the efficiency level of 40.26 and 40.62. This is a clear indication that farmers in the study area are making inefficient use of resources. However, they can greatly increase their efficiency by adopting improved technology and farming practices to enable them to attain higher technical efficiencies. Farmers having efficiency levels less than 50% is not uncommon in Nigeria. Oladimeji and Abdulsalam (2013) also reported about

40% of rice farmers in Kwara State have technical efficiencies below 45%.

Table 4: Technical Efficiency Scores for Rice Farmers in Niger State

Efficiency score	Frequency	Percent
<= 30.50	2	0.4
... ...	31	5.2
30.89 – 40.25	290	48.4
40.26 – 40.62	258	43.0
40.63 – 50.01	18	3.0
Total	600	100

Source: Base Line Survey, 2020

Determinants of Technical Efficiency

The stochastic production frontier results as presented in Table 5 show that farmland and seed variables are significant at 1 percent level. Herbicide variable on the other hand was significant at 5% level of significance. The results however indicated that the fertilizer variable was not significant. The signs of the significant variables indicate a positive relationship with the dependent variable. This implies increase in farmland, seed and use of herbicide would increase farm output in the study area. The explanatory variables for the technical inefficiency with respect to inputs show seed have a positive relationship with the inefficiency variable. This means that seeds planted are not efficiently allocated with respect to land ratio. This can be explained by the fact that most of the farmers broadcast the rice seeds, and they do so not sparingly which may lead to over seeding. The results further indicate that fertilizer and herbicide variables have a negative relationship with inefficiency. This means that the application of the two inputs by the famers is still within the threshold of efficiency. The trend of inefficiency in the allocation of resources among the farmers may be an indication that the expected benefits from the cultivation of rice are not fully realized by the farmers in the study area. The generalized likelihood ratio estimated at -174/89 is significant at 0.01 level; this suggests the presence of one-sided error component and significant technical inefficiency in the production function. Thus, estimation of the regression equation using a classical ordinary least square model would be inadequate representation of the data. This confirms the relevance of stochastic parametric production frontier and maximum likelihood estimator for the data generated from this study.

Table 5: Stochastic Frontier Production Function of Rice Producers in Niger State

Variables	Coefficients	Standard Error	Z	P>z	95% Confidence Interval	
Land	0.282	0.027	10.60	0.000	0.2297	0.3340
Labour	0.028	0.063	0.44	0.660	-0.0962	0.152
Seed	0.222	0.029	7.61	0.000	0.1649	0.279
Fertilizer	-0.008	0.008	-1.00	0.319	-0.0248	0.008
Herbicides	0.039	0.011	3.37	0.001	0.0165	0.063
Constant	3.819	0.226	16.88	0.000	3.3761	4.262
lnsig2v						
Constant	-3.141	0.179	-17.43	0.000	-3.464	-2.763
lnsig2u						
Land	0.174	0.157	1.11	0.268	-0.133	0.481
Labour	0.421	0.402	1.05	0.295	-0.366	1.207
Seed	0.364	0.145	2.51	0.012	0.079	0.649
Fertilizer	-0.291	0.042	-6.93	0.000	-0.372	- 0.208
Herbicides	-0.152	0.058	-2.64	0.008	-0.265	- 0.038
Age	-0.027	0.010	-2.61	0.009	-0.046	- 0.006
Gender	-0.539	0.239	-2.25	0.024	-1.008	- 0.070
Marriage	-0.027	0.162	-0.17	0.867	-0.345	0.290
Education	-0.147	0.084	-1.740	-0.313	0.019	
Constant	-0.948	1.615	-0.59	0.557	-4.11	2.217
Sigma v	0.211	0.018			0.177	0.251
Log likelihood	-174.894					
Prob> chi2	0.000					
Wald chi2	244.60					

Source: Field survey, 2020

For the socioeconomic factors explaining the inefficiency on the farms, age and gender of the farmer have a negative relationship with the inefficiency variable. By implication, farmer age and gender decrease the inefficiency on the rice farms in the study area. In other words, older farmers are more efficient than young farmers. This may be related to the fact that the older the farmer gets, the more experience he acquires and by implication the better they becomes in utilizing productive resources. Also, gender plays a role in the inefficiency level obtainable on the farm. The results imply that male farmers are more efficient than their female counterpart. This may be attributed to the fact that the male farmers have all the time and independence to plan and carry out activities on their farms without many encumbrances associated with the female gender. The female farmers usually must contend with family chores which may take up most of their time away from farming activities

Conclusion and Recommendation

Lowland paddy production in Niger State is profitable. However, majority (62%) of the sampled farmers reported less than two tons of rice per hectare. The average efficiency level among the farmers in the study area is 41%. Therefore, to sustain profitability and boost efficiency levels farmers in the study area would require extensive trainings in improved production practices. Having observed that the major constraint facing the farmers is inadequate fund, there is dire need for both private and Government agencies to join hands in providing loans for the farmers to improve accessibility.

Acknowledgment:

This work was funded by the Tertiary Education Trust Fund (**TETFUND**), Nigeria. Under the National Research Grant Programme. The authors appreciate TETFund for this support. We also thanked the management of Ibrahim BadamasiBabangida University (IBBU) Lapai, Nigeria that provides the enabling environment that supports the completion of the project**.**

References

Adewuyi, A. K. and Amurtiya, M. (2021). Economic analysis of rice production by small-holder women farmers in Adamawa State, Nigeria. Croatian Review of Economic, Business and Social Statistics (CREBSS), Vol. 7, No. 1, 2021, pp. 1-12Ahmed, A., Xu, S., Yu,W., & Wang, Y. (2017). *Comparative Study on Factors Influencing Rice Yield in Niger State of Nigeria and Hainan of China*. Agricultural and Food Research [IJAFR] Vol. 6 No. 1, pp. 15-25

Aigner, D. Z.; Lovell, G. A; Schmidt, P. (1977): "Formation and Estimation of Stochastic Frontier Production Models" *Journal of Econometrics,"* 6: 21 – 37.

Ayedun, B. and Adeniyi, A. "Efficiency in Rice Production in Nigeria". Acta Scientific Nutritional Health 3.7 (2019): 86-94.

Badawi, T. A. (2004). Rice Based Production System for Food Security and Poverty Alleviation in the Near-East and North Africa. Available at http://www.faw.org/rice2004/en/pdf.badawi.pdf retrieved on 18 September 2020.

Bitrus A., Yakubu H., Patrick T., and Stephen S. F (2021). Economics of Rice Production among Beneficiaries of Anchor Borrowers Programme in Gerie Local Government Area of Adamawa State, Nigeria. Asian Journal of Agricultural Extension, Economics & Sociology, 39(1): 82-95, 2021.

Boundeth, S., TeruakiNanseki and Shigeyoshi Takeushi (2012). Analysis on Technical Efficiency of Maize Farmers in the Northern Province of Laos. *African Journal of Agricultural Research Vol. 7(49), pp. 6579-6587, 27 December, 2012.*

Bwala, M. A., H.S.C Kokoye, R.N.Yegbemey. 2015. Technical Efficiency of Cereal Production in North Central Nigeria: A Case for Maize, Rice and Sorghum Farmers. Journal of Agricultural Science and Development

de Wit, C. T. (1992). Resource Use Efficiency in Agriculture Agricultural Systems 40 (1992) 125-151

Danmaigoro, A., (2019) Evaluation of Profitability and Technical Efficiency of Irrigated Rice Production in Kebbi, Nigeria. International Journal of Innovative Research and Advance Studies Vol 6, (8)

Forsund, R.; Knox, C.A.; Lovell,C.A.F; and Schmidt, P. 1980): "A Survey of Frontier Production Function and of their Relationship to

Efficiency Measurement". *Journal of Econometrics,* 13: 5 – 25.

International Food Policy Research Institute (IFPRI) (2016). Agricultural Productivity in Africa, Trends, Patterns and Determinants. University of Pennsylvania Press Philadelphia.

Lawal, A. F; A. Liman, D. A. Ibrahim and L.T. Yusuf (2014) "Technical Inefficiency and Sustainability of Rice Production in the Fadama of Niger State, Southern Guinea Savannah,Nigeria" *India Journal of Life sciences 3(2):15-25* also available at www.ijls.in

Meeusen, W. and van Den Broeck, J. (1977) Efficiency Estimation from Cobb-Douglas Production Functions with Composed Error. International Economic Review, 18, 435-444. http://dx.doi.org/10.2307/2525757

Nigerian Institute of Social and Economic Research (NISER) (2001). Price and trade incentives in Nigerian crop, livestock, fisheries, and forestry production. Final research report submitted by NISER to the Department of Agriculture and Rural Development, Federal Ministry of Agriculture and Rural Development.

Obianefo C.A., Nwigwe C.A., Meludu T.N., and AnyasieIkechukwu C., (2020). Technical efficiency of rice farmers in Anambra State value chain development programme. Journal of Development and Agricultural Economics, Vol. 12(2), pp. 67-74, April-June 2020.

Obianefo CA, Aguaguiyi NF, Umebali EE, Ezeano CI (2019). Comparative Analysis of Rainfed and Dry Season Rice Farming in Value Chain Development Programme in Ayamelum Local Government Area- Anambra State. International Journal of Science and Research 8(7):1655-1659.

Ohen, S. B., &Ajah, E. A. (2015). Cost and return analysis in small scale rice production in Cross River State, Nigeria. International Research Journal of Agricultural Science and Soil Science Vol. 5(1) 22-27.

Oladimeji,Y. U. and Abdulsalam, Z. (2013). Analysis of Technical Efficiency and Its Determinants among Small Scale Rice Farmers in Patigi Local Government Area of Kwara State, Nigeria. Journal of Agriculture and Veterinary Science Volume 3, Issue 3 (May. - Jun. 2013), PP 34-39

Oyedepo, E. O., &Adekanmbi A. A. (2018). Profitability analysis of ofada rice production in Ogun State. Nigeria Journal of Agricultural Science and Environment, 18(1&2), 97-106.

Porcelli, F. (2009) Measurement of Technical Efficiency. A Brief Survey on Parametric and Non-Parametric Techniques.

http://www.warwick.ac.uk/fac/soc/economics/staff

Rahji, M.A.Y. (2005). Determinants of Efficiency Differentials in Lowland Rice Production Systems in Niger state, Nigeria. *Ibadan Journal of Agricultural Research, 1*(1): 7-17.

Subedi, S., Ghimire, Y.N., Kharel, M., Adhikari, S.P., Shrestha, J., &Sapkota, B.K. (2020). Technical efficiency of rice production in terai district of Nepal. Journal of Agriculture and Natural Resources, 3(2), 32-44.

Swiss Agency for Development and Cooperation (SDC) (2015). Financial and economic analysis of projects with a focus on Cost Benefit Analysis (CBA) and Cost Effectiveness Analysis (CEA). SDC How-to-Note. Swiss Agency for Development and Cooperation (SDC), Federal Department of Foreign Affairs (FDFA).

Ugalahi U. B., et al (2016). Irrigation potentials and rice self-sufficiency in Nigeria: A review. African Journal of Agricultural Research 11.5 (2016): 298-309.

United States Department of Agriculture (USDA) (2014): Agricultural Statistic. U.S. Government. Washington. Printing Office. DC Area 202:512-1800.