THE EFFECT OF WATER QUALITY ON PAP IN MINNA METROPOLIS

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THIS PROJECT IS SUBMITTED TO THE DEPARTMENT OF AGRICULTURAL ENGINEERING IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF POST GRADUATE DIPLOMA IN AGRICULTURAL ENGINEERING (SOIL AND WATER OPTION)

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DECLARATION

I hereby declare that this Project Work was done by me under the supervision and guidance of Engr. Prof. E.S.A. Ajisegiri of the Department of Agricultural Engineering, Federal University of Technology, Minna. I have neither copied someone's work nor someone else done it for me. Writers whose work has been referred to in this project has been acknowledged.

MOHAMMED TANIMU MUSA

....
SIGNATURE

CERTIFICATION

This is to certify that this project is an original work undertaken by MOHAMMED TANIMU MUSA PGD/SEET/01/02/169 and has been prepared in accordance with the regulation governing the preparation and presentation of Postgraduate research project in Federal University of Technology, Minna.

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DEDICATION

This Project is dedicated to my parents Mallam Musa Usman and Safawu Musa and the entire family.

ACKNOWLEDGEMENT

All thanks and praises be to the Almighty God who has protected and given me the strength to complete this programme successfully.

I wish to express my sincere gratitude to my able supervisor, Engr. Prof. E.S.A. Ajisegiri whose patience and effective supervision has made this project a reality. His critical observations and advice at various levels have been vital to this research work.

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ABSTRACT

The sanitary quality of water is the relative extent of absence of suspended matter, colour, taste, odour, unwanted dissolved chemical, bacteria indicative of feacal presence and other aesthetically offensive objects/properties. Water samples were collected from rain, well and Tap and their physical and chemical properties analyzed. 3kg of sorghum (red) was purchased from Minna main market. The sorghum was shared into three equal parts and steeped with a portion of each analysed water sample for 48hours. Then, the sorghum was wet milled, wet sieved and allow to stand for about 4 hours and the sour water decanted. Samples were taken for microbiology analysis, including texture, colour, taste and odour. The result indicated that the well water had highest total dissolved and suspended solids (147.9mg/l and 30mg/l), and highest turbidity of 3 FTU and conductivity of 290 µs/cm. Highest Aerobic plate count revealed that the tap water had highest colony forming unit/ml of 180×10^3 cfu/ml of bacteria as against rain and tap water of 150×10^3 cfu/ml each. The textures were sticky, firm, soft and powdery when dried. The rain and tap water were found to be the best.

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CHAPTER ONE

0 INTRODUCTION

1 History/origin of Guinea-corn (Sorghum)

Sorghum belongs to cereal crops of grass family of plant called gramineae. It is the faith most important cereal crop after wheat, rice and maize. Sorghum constitutes a major source of energy and protein for millions of the World poorest people in the Sahelian Zone of Africa, the Near East, Middle East, India and China where it has been cultivated for at least 4000 years.

Sorghum is believed to have originated in the Tropical Africa where wild forms of the species still exist. It is known to have migrated from East Africa via South West Asia to India, were archaeological finding confirm its cultivation from about 2000BC. It is also grown in significant quantities in the United State, as animal feed up to about 15% of the average diet.

It has a relatively low water needs as well as efficient use of moisture and drought resistance characteristics. These are some of the reasons why sorghum do well in most tropical regions of the world. According to Food and Agricultural Organization (FAO) Statistics, the average annual global production of sorghum in 1984 was about 71.7 million tones. (FAO production yearbook, 1985). Various terms are used to refer to sorghum according to the local name or the place of cultivation, the major group being the white or red-seeded variety called sorghum bicolor.

.2 Uses of Sorghum

In developing countries, Sorghum serves as a major source of staple food, energy and protein for millions of the populace. On the other hand, Sorghum is mainly used as food and feed in the developed countries, Sorghum is commonly consumed as Akamu (Ogi).

Pap (Ogi) is a common traditional weaning food for children, and taken as break fast by adult in many African and Latin American Countries. Besides the fact that percentage protein in Maize is rather low for the purpose of weaning children, maize is known to be deficient in lysine and trytophan These make sorghum one the best choice of Akamu for weaning children.

.3 Processing of Pap

In the processing of pap, the sorghum is first cleaned to remove stones and impurities The cleaned sorghum is steeped in water for 2-3 days at room temperature

(29^{oc}-31^{oc}) and allowed to soak. The steeped sorghum is washed and wet-milled, wet sieved and sour for at least 12 hours. The final product (paste like sediment when mixed with little cold water and stirred in boiling water produce a thin gruel (Porridge) called pap. Pap Can also be cooked and turned into a stiff gel, called Eko, Kafa or Agidi.

From the public health point of view, the water used for food processing (Akamu inclusive) should be absolutely safe to drink – free from sewage contamination. The water should have an acceptable taste, odour, colour, clarity, chemical composition and the bacterial content should meet the standard for drinking water quality. This is because the quality of water used for processing food (Akamu) will in turn affect the final product.

4 Water Quality

Water sustains life and is therefore necessary to keep it safe. Ideally, drinking water should not be coloured, and should not contain any microorganisms known to be pathogenic. It should also be free from odour or taste. Indication of any of the above shows contamination or low quality. Immediate sanitary inspection, microbiological, physical or chemical analysis of the water is therefore necessary to determine its quality for consumption or processing. The results obtained should be compared with World health Organization to ascertain its safety.

Well water, tap water and rainwater were collected and analyzed. The samples were confirmed to be of good quality and used to steeped and process the sorghum for Pap.

The Pap obtained from the three samples were also analyzed for colour, texture, taste and microbial load.

.5 Statement of Problem

Most people in developing countries do not have access to pipe-borne water. Most of them rely on hand-dug well, stream water and rain water for their domestic uses. Cooking and processing are always done with any of the above sources of water available to them. It is also common to see variations in food processed in one community different from the other community. These variations in colour, taste and texture of Akamu necessitate the study.

.6 Objectives of the Study

Unusual colour, taste and odour may develop within the food through chemical or microbial action or during processing, storage, or packaging. The objectives of this project are;

i. Identifying the effect of water quality (well, rain and tap water) on Pap

ii. Identifying the number of microorganisms present in the different samples of Pap prepared from the three sources of water.

iii. Identifying the effect of water sources on the colour, taste, odour and texture of Pap

iv. Finally, the project will recommend ways to improve the quality of Pap

1.7 Significance of the Study

Pap is a common traditional weaning food for children. It is also used as breakfast by adult in many African and Latin American Countries. Unpleasant odour/taste may be indicative of microbial spillage. These unusual colour, taste and texture of pap may poses some health risks to the consumers.

This study is carried out to eliminate the potential danger pose to the public and the consumers of Pap. The result of the analysis will give an idea to the best water e use for pap processing.

1.8 Scope of the Study

The scope of the project covers the effect of Well water, Rain water and Tap water on Akamu using red sorghum. 'The physico-chemical, and biological analysis of the water and Akamu will be carried out, result obtained would be discussed and recommendations given.

1.9 Limitation

The study did not cover other cereal crops because of time and financial factor.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Sorghum Varieties

Guinea Corn (**Sorghum vulgare**) is one of the major cereal crops that serve as staple food for millions of people in many African and Latin American countries (Oyenuga 1978) local names or places of cultivation are commonly used to describe sorghum varieties/groups. The major varieties include;

i. CAFFRORUM GROUP: - Sorghum in this group has dry and pithy stalks that are not very juicy. They have flinty grains e.g. Kafir, Milo Hegari (Kochhar, 1984).

ii. SACCHARATUM GROUP (Sweet-stemmed sorghum):- They have juicy and sweet stalks that are used as forage and silage. The stalks can also be used to make sweet syrup.

iii. TECHNICUM GROUP (broom corns): They have small seeds and long tough fibrous branches. They can be used in making brooms and whisk brooms.

iv. SORGHUM BICOLOR (GRAIN SORGHUM): This group has tall, white or red seeded variety of sorghum. They can also be grown for pasture, green chop, silage or hay (Kochhar, 1984).

2.2 Uses of Sorghum

According to Asiedu 1989, Sorghum is used almost entirely for human consumption in developing countries while it is used mainly as feed in developed countries. The major uses of sorghum in some parts of the World include the following:-

i. The dry grain is ground to make either a meal or flour from which a think paste (tuwo) is prepared or grits from which burabusko is obtained.

ii. The Dry grain is roasted and then ground from which snacks like pop-corn or (guguru) is obtained, (Kent, 1982)

iii. The grain is steeped in water and a lactic fermentation allowed to proceed for 1-2 days. The wet grain is wet milled and sieved. The paste-like sediment is used to prepare porridge product called Akamu or a thinker paste called Eko, Agidi (Oyenuga, 1990).

iv. The grains are soaked and allowed to sprout. The sprouted grains are dried and ground to make a malt from which beverage like Pito or Burukutu are obtained (Kent, 1982)

v. In India and other Asian countries, whole meal flour from sorghum is used to make dry unleavened pancake (Chapatti et al 1984)

vi. In the United State of America, one percent of sorghum produced annually is used for purposes of animal feeds which include;

  a. Wet milling to make starch and its derivatives with edible oil and gluten feed as by products. The starch is used in food production, adhesives and sizing.

  b. Dry milling to make low protein flour which is used for adhesive and used in oil-well drilling muds.

  c. Used in fermentation industry for brewing, distilling, and the manufacture of industrial alcohol (Kent, 1982)

vii. It can be roasted, ground, mixed with ground-nut to produce "Donkowa"

2.3.0 Processing of Pap (Sorghum)

Pap is mostly processed locally and involve wet milling. According to Chakraverty 1981, the sorghum for wet milling should contain about 15-16 percent moisture and should be physically sound.

Sufficient amount of moisture (Water) is added during steeping in order to prepare it for subsequent degerming, grinding and separation operation.

The wet milling process consists of cleaning, soaking (steeping) grinding and sieving.

2.3.1 Cleaning

This process involves removal of all impurities such as dust, chaff, cobs, stones, insect-infected grain and other foreign materials from the sorghum by screening and aspirating.

2.3.2 Steeping (Soaking)

Steeping is the process of soaking the clean grains in water. The major objectives of steeping include softening the kernel for grinding and to remove soluble mainly from the grain. The steeping is usually 24-72 hours (1-3 days). (Chakraverty, 1981).

2.3.3 Milling

Sorghum is usually milled locally with simple grinding machine (engine). The steeped grain undergoes lactic fermentation between 1-3 days. The moist grain is then pounded or milled in a grinding engine to reduce the size and allow for easy separation (Aladesanmi 1990).

According to Aladesanmi 1990, the wet milled sorghum is immediately wet sieved using a 425-micron aperture sieve. The resulting liquor is left to stand for about 4 hours after which the supernatant (souring water) is decanted. The paste-like sediment (Akamu) is therefore obtained. The paste can be dried or refrigerated to avoid spoilage.

2.4.0 Quality Assessment of Water/Akamu

The quality assessment of water includes physical, chemical and microbiological examination, each having its use and indication. Quality assessment serves the purpose of ensuring the safety of consumer goods or the quality of other goods in a condition that will ensure suitability for their intended utility (Ajisegiri 2001). It also provides the basis for comparison and hence uniformity within and between countries.

Fresh and processed foods are often spoilt by presence of undesirable flavour, taste, odour and colour caused by either microbial action or chemical action (Whitfield, 1989). Most consumers instantly realize that such food, if consumed will be harmful to their health.

Water used for food processing should have an acceptable taste, odour, colour clarity, chemical composition and the bacterial content should meet the standard for drinking water (Frazier, 1986).

Quality assessment may be either subjective or objective depending on the mode of assessment. Subjective assessment is made usually by human five senses of feel, sight, sound, taste and smell judgement (Piggott, 1988). On the other hand Objective evaluation makes use of instruments to measure the parameters. A set standard exists for comparison and human flaws are minimized (Ajisegiri 2001).

The qualities considered are;

2.4.1 Colour

Colour is probably the most important appearance characteristics of food, especially if some other aspects of quality are related to colour (Macdaugall, 1988). For example, pure water is supposed to be colourless and a freshly processed Akamu have fine colour. The presence of unusual colour in Water/Akamu indicates the presence of dissolved material or colour organic mater e.g. Iron (W.H.O., 1983)

2.4.2 Taste and Odour

The combined perception of substance detected by the senses of taste and smell is often called "taste". (Gardiner T and Zabel 1989). Water and food odour are due mainly to the presence of organic substances. Some odours are indicative of increased biological activity; others may result from pollution (W.H.O., 1984)).

According to W.H.O., 1984 the guideline criterion for drinking water is "not offensive to most of the consumers". In man, the receptors of taste are mainly situated on the tongues surface and spread over the entire oral cavity and down the esophagus and even on the trachea and the larynx (Platting, 1998). The senses of taste and odour can be measured or evaluated by human sense.

Generally, the taste buds in the oral cavity specifically detect inorganic compounds of metal such as magnesium, calcium, iron etc.

2.4.3 Texture

Texture is the attribute of a substance resulting from a combination of physical properties and perceived by the senses of touch (including mouth feel}, Sight and hearing (Piggott, 1988). From above texture is clearly defined as sensory attribute and only measured directly by sensory means. A glossary of textural terms as proposed by Jiwitt (1974), relating to the structure of the material like size, and shape for example smooth, powdery gritty, mealy and terms relating to mouth feel characteristics as juicy, greasy, and creamy are mostly used.

The behaviour of liquid or semi liquid foods when shaken, poured or spread may yield information about their viscosity, smoothness or stickiness.

2.4.4 Micro- Organisms

Ideally, drinking water should not contain any micro-organisms known to be pathogenic. It should also be from bacteria indicative of excremental pollution. (W.H.O. 1983). The primary bacterial indicator recommended for the purpose of drinking water standard in the coliform group of organisms.

Fresh and processed foods are often spoilt by presence of undesirable flavours and odours caused by microbial action (Whitfield, 1998). Micro-organism that can cause food taints is bacterial, fungi and yeast. The physical characteristics that affect their growth are water activity, P.H, and the temperature and atmospheric condition under which the food is stored. Water use for processing or drinking should have acceptable bacterial content as specified by W.H.O. (Frazier, 1986).

2.4.5 Turbidity.

The presence of colloidal solids gives liquid a cloudy appearance which is aesthetically unattractive and may be harmful, turbidity in water may be due to clay and silt particles, discharges of sewage or industrial wastes, or to the presence of large number of micro-organisms (Gardiner and Zabel, 1989). Turbidity is measured by a turbidimeter in Nepherometric Turbidity Unit (NTU) or Formazin Turbidity Unit (FTU) depending on the one available.

2.4.6 Dissolved Solids

Solids may be present in suspension and /or in solution, which may be divided into organic matter and inorganic matter. Total Dissolved Solids (TDS) due to soluble materials whereas Suspended Solids (SS) are discrete particles, which can be measured by filtering a sample through a fine paper. Dissolved solids are objectionable even in low concentration (Gardiner and Zabel, 1989).

2.4.7 Conductivity

Conductivity is the measurement of the ability of a solution to carry electric current. The conductivity of a solution depends on the quantity of dissolved salt present and for dilute solutions, it is approximately proportional to the total dissolved solids (TDS) content. For most waters, a factor in the range of 0.55-0.70 multiplied by the conductivity gives a close approximation of the dissolved solids in mg/l. Conductivity has a unit microsiemen per centimeter (μs/cm).

$$K = \frac{\text{Conductivity (s/m)}}{\text{Total Dissolved Solid (mg/l)}}$$

$$K = \text{Water factor value } (0.55 - 0.70)$$

Most work done in this field include the effect of sorghum/corn varieties on Ogi quality, microbiological, chemical and nutritional changes that lead to undesirable flavour, taste, odour and colour in processed foods, acceptability of maize "Ogi" flour blended with Bovine blood plasma protein.

A lot is needed to be done on how water quality used for the processing affects Akamu and its microbiological quality. This work is therefore undertaken to provide information on the effect of various water sources (Rain, Tap and Well water) on quality of Akamu. Vis-à-vis its colour, taste, texture and microbial loads. The work will give suggestions on the best water source to be used and give recommendations on how to improve the quality of the other sources.

CHAPTER THREE

3.0 METHODOLOGY

(Project Location)

The project was carried out in Tunga Area in Minna, Niger State. Water samples used for the analysis were from Tap water, Well water and Rain water. Samples collected were analyzed at Niger State water Board (Gidan Ruwa) along the Western Bye Pass Minna. The project is to reveal to what extent water quality from the three sources affect Akamu – vis-à-vis colour, taste, texture and microbial load.

3.10 Sample Collection

Rainwater, Tap water and Well water were collected at Tunga Village; Minna in a sterilized four (4) litre can for the analysis.

A container (Guga) was plunged into a shallow well and filled with water. The water was turned into the four (4) litre can. The well is a shallow type of about 9 metre depth, hand dug type and covered.

The well serves as a major source of domestic water within the vicinity. People interviewed said the well stores water all year round.

Tap water was collected directly from the running tap while a bowl was placed outside during rainfall to collect rainwater.

Sorghum (Red Guinea-Corn) used for the project was purchased from Minna Central Market weighing about 3.0 kilogram.

The Samples were designated as follows:

Sample A	=	Tap Water
Sample B	=	Well Water
Sample C	=	Rain water
Sample A_1	=	Tap Water +Pap (Amaku}
Sample B_1	=	Well Water + pap {Akamu }
Sample C_1	=	Rain Water + Pap}{Akamu}

3.2 Experimental Procedures

The water samples were first analyzed to determine water quality parameters.

The sorghum was divided into three (3) portions each weighing about one (1) kilogram. The portions were washed and steeped into about 1.9 litre of the three (3) water sources analyzed. The steeped sorghum were at room temperature of about 29^{oc}-31^{oc} for 48 hours. The sorghum was wet milled and wet sieved using a 425 micro aperture sieve.

The resulting liquor was left to stand for 5 hours after the souring water was decanted. Samples of Akamu were taken from the three sources of water for analysis for colour, taste, texture and microbial load.

3.3 Material/Reagents Used

1. Weighing Balance
2. Sorghum
3. Distilled water
4. Desiccators
5. Water samples (Well, Rain and Tap)
6. Thermometer
7. Lovibond colour comparator (Bicasa Model/Product)
8. Petri Dishes
9. Hach Conductivity/TDS meter
10. DR/2000 Direct reading spectrophotometer
11. Test-tubes
12. Syringes and Needles
13. Masking tape
14. Wall clock/stop watch
15. 25ml sample cells
16. Measuring cylinder (Volumetric flask)
17. Conical flasks
18. Pipettes
19. Universal p.H. strips
20. Iron Reagent Powder Pillow
21. Sulphover 4 Reagent Powder Pillow
22. Alkali Solution
23. Ethylene Diamine –Tetra-acetic acid (EDTA) Solution
24. Ehylebis (Oxyethylenenitrilo) Tetra-Acetic (EGTA) solutions
25. Phenol red indicator
26. Clean towel
27. Nutrient agar
28. Bunsen burner
29. Autoclave (sterilized medium)
30. Colony counter
31. Ethanol (Acetic acid)
32. Cuvett (sample cell l0ml)

33. Bibby hot plate

34. Dissolved Oxygen ciba corning meter

3.4 METHODS OF ANALYSIS

3.4.1 Water Analysis

Determination of Temperature

1. Temperature/Conductivity/TDS meter was switched on.
2. The probe was rinsed by immersing it in a beaker containing deionized water.
3. The probe was immersed in the beaker containing the samples and moved up and down and tapped on the beaker to free any bubbles from the electrode area. The probe was immersed beyond the vent holes.
4. The temperature readings from the meter were recorded.

3.4.2 Determination of Conductivity

1. The conductivity/TDS meter was switched on
2. The probe was rained by immersing it in deionized water.
3. The probe was immersed in the beaker containing the samples.
4. The probe was moved up and down and tapped on the beaker to remove bubbles from the electrode. The probe was then immersed beyond the vent holes.
5. The reading were recorded from the meter in microsiemens per cm (μs/cm)

3.4.3 Determination of Total Dissolved Solids (TDS)

1. The conductivity/TDS meter was switched using the appropriate buttons.
2. The probe was raised by immersing it in a beaker containing deionized water.
3. The probe was immersed in the beaker containing the samples. The probe was moved up and down and tapped to the beaker to remove bubbles from the electrode area. The probe was immersed beyond the vent holes.
4. The reading was recorded in milligram per liter (mg/l) or grams per liter (g/l).

3.4.4 Determination of Suspended Solids

1. The stored program number (630) for suspended solids was pressed on the spectrophotometer.
2. The wavelength dial was rotated to show 810nm.
3. Read/enter button was pressed to show mg/l suspended solid.
4. 25ml of sample cell was filled with deionized water as blank.
5. The blank was placed into the cell holder and the light shield was closed.

6. Zero was pressed and the machine displayed "WAIT" and then. 0mg/l suspended solids.
7. The prepared sample cell was swiveled to remove any air bubbles and to uniformly suspend any residue.
8. The prepared samples were placed into the cell holder. The light shield was closed.
9. Read /Enter buttons was pressed. Results in mg/l suspended solids were displayed.

3.4.5 Determination of p.H

1. 2 clean 10ml cuvettes were used for each sample.
2. Distilled water was filled in one of the cuvette as blank.
3. The Samples were filled in one of the cuvette and 1 to 2 drops of phenol red was added.
4. The phenol disk was placed in the lovibond comparator and rotated for colour matching. The readings were recorded.

3.4.6 Determination of Colour

1. The Stored program number (120) for true colour was entered on the spectrophotometer.
2. The wavelength dial was rotated to 455nm.
3. Read/Enter button was pressed and it displayed platinum cobalt (PtCo)
4. A blank of 25ml deionized water prepared in a sample cell
5. The blank was placed into the cell holder and the light shield was closed.
6. Zero was pressed and the machine displayed "WAIT" and the 0unit PtCo colour.
7. The prepared sample was placed into the cell holder and the light shield was closed.
8. Read/Enter was pressed. Results in platinum-cobalt units were displayed. When the result stabilized, the results were recorded.

3.4.7 Determination of Turbidity

1. The stored program number (750) for turbidity was entered.
2. The wavelength dial was rotated until the small display 450nm.
3. Read/Enter button was pressed to show F.T.U. Turbidity.
4. 25ml of deionized water (blank) was filled into the sample cell.
5. The blank was placed into the cell holder and the light shield was closed.

6. Zero was pressed and the machine displayed "WAIT" and then 0.1 Formazin Turbidity unit (FTU)

7. The prepared sample was placed into the cell holder and the light shield was closed.

8. Read/Enter was pressed, it displayed "WAIT" and then results in Formazin Turbidity units were displayed and recording was done.

3.4.8 Determination of Nitrite

1. The stored program number (371) for Nitrite was entered on the spectrophotometer and the wavelength 507nm was displayed.
2. The wavelength dial was rotated to 507nm.
3. Read/enter button was pressed to show mg/l Nitrite as expressed as Nitrogen (NOJ-N)
4. 25ml of deionized water (blank) was filled into the sample cell and placed into the cell holder, then the light shield was closed.
5. Zero was pressed and the machine displayed "WAIT" and the 0mg/l Nitrite.
6. Nitri-ver 3 Nitrite reagent powder was dissolved in the sample and allowed to stand for 15 minutes.
7. The prepared sample was placed into the cell holder and the light shield closed.
8. Read/Enter was pressed and the result in mg/l Nitrite was recorded.

3.4.9 Determination of Iron

1. The stored program for Iron was entered on the machine.
2. The wavelength dial was rotated to 510nm.
3. Read/enter was pressed to show mg/l fe fv.
4. Ferover iron reagent powder was added to the samples and reaction allowed for 3 minutes.
5. A blank sample was prepared and placed into the cell holder and the light shield closed.
6. The machine displayed "WAIT" and the 0mg/l fe fv.
7. The prepared sample was placed into the cell holder and Read and Enter was pressed. Results in mg/l were recorded.

   NB: An orange colour indicates the presence of iron and reactions was allowed for up to 5 minutes.

3.4.10 Determination of Dissolved Oxygen

Dissolved oxygen ciba corning meter was used.

1. Samples were placed in a conical flask.

2. The sensor-wetting cap for dissolved oxygen was gently removed.

3. The Mode/Read/CAL/M button was pressed on the machine to turn on the meter.

4. The sensor was gently placed into the solution (samples)

5. The results were automatically displaced digitally in mg/l O_2. Distilled water was used to rinse the sensor tip when transferring to another sample (solution).

3.4.11 Determination of Sulphate

1. The stored program number (680) was entered.
2. The wavelength dial was rotated to 450nm.
3. Read/Enter was pressed to show mg/l So_4^{2-}
4. sulfo-ver 4 reagent powder pillow was added to the samples and reaction allowed for 5 minutes.
5. A blank sample was prepared and placed into the cell holder and the light shield was closed.
6. Zero was pressed and the machine displayed "WAIT" and the 0mg/l SO_4^{2-}.
7. The sample was placed into the cell holder and Read/enter was pressed. Results in mg/SO_4^{2-} were displayed and recorded.

   <u>NB</u>: A white turbidity developed signifies the presence of sulphate.

3.4.12 Determination of Total Hardness (Magnesium and Calcium)

1. 100ml of the samples were prepared in graduating mixing cylinder.
2. 1.0ml of calcium and magnesium indicator was added and inverted and mix thoroughly.
3. 1.0ml of Alkali solution for calcium and magnesium test was added and inverted several times to mix.
4. One drop of 1M EDTA solutions was added to the sample cell (blank) and allowed to mix.
5. One drop of EGTA solutions was added to two samples and swirled to mix.
6. A stored program number (225) for magnesium was entered.
7. The wavelength dial was rotated until it displayed 522nm.
8. Read/Enter was pressed and it displayed mg/l $CaCO_3$ mg.
9. The blank cell was placed into the cell holder. The light shield was closed and zero was pressed. The displayed showed 0.00mg/l $CaCO_3$ mg.
10. The prepared sample was placed into the cell holder and read/enter was pressed

11. CONFIG/METH button was pressed twice and a stored program number (220) for calcium was entered.
12. The wavelength dial was rotated to 522nm.
13. Read/enter was pressed and "WAIT" was displayed then 0.00mg/l $CaCO_3$ Ca.
14. The second sample was placed into the cell holder.
15. Read/Enter was pressed. Results in mg/l ca as $caco_3$ was displayed and recorded.

NB: mg/l hardness is equal mg/l ca as $caco_3$ plus mg/l mg as $caco_3$.

TO CONVERT FROM	TO	MULTIPLY BY
mg/l Ca as $CaCO_3$	mg/l Ca	0.400
mg/l Mg as $CaCO_3$	mg/l Mg CO_3	0.842
mg/l Mg CO_3	mg/l Mg	0.29
mg/l Mg as $CaCO_3$	mg/l Mg	0.243

3.4.13 DETERMINATION OF ODOUR/TASTE

The Odour/Taste assessment was done by six (6) assessors.

1. Sample was taken and poured in 500ml of conical flask.
2. Each sample was diluted to 200ml with odour free water and shake
3 The dilutions were heated to 40-60^{0}c the vapour was sniffed.
4. The sniffing was repeated after shaking the flask and observation of the odour was recorded.

3.5.0 Analysis of Akamu

3.5.1 Determination of Colour

Measurement was by direct comparison with distilled water (standard) using formazin haze with platinum – cobalt scale.

1. 10ml cuvette was filled with distilled water (blank)
2. Sample of Akamu solution was prepared in another cuvette of 10ml.
3. The blank sample was placed on the right side of the machine while the prepared sample was pleased on the left hand side.
4. Formazin-haze colour disk was placed and rotated to match the colour.
5. The number on the disk corresponding to colour was recorded.

3.5.2 Determination of Texture

1. The method used was hand feel (touch). Little sample of the Akamu was dried.
2. Small quantity was taken and rubbed between the fingers to fill its size and shape.
3. Results/observations were recorded.

3.5.3 Determination of Microbial Level

The method involves media preparation and inoculation.

1. 28g of nutrient agar were weighed and pour into 1liter of distilled water.
2. The sample (media) was heated for 10minute and stirred.
3. The media was then autoclaved at 121^{0}c for 15 minutes and brought out to cool at 40-45^{0}c.
4. Then 9g dried Akamu was added to 9ml of distilled water and distributed into 6 test-tubes
5. 1ml of the sample was added to the first test tube with the aid of syringe and needle.
6. 1ml of the sample was taken from the first test tube and added to the second test- tube. The dilution was done serially until, the 6th test-tube having the least concentration. The test-tubes were labeled from 10^{-1}-10^{-6}
7. 1ml of 10^{-1}, 10^{-3} and 10^{-6} were placed in to 3 different petri dishes and placed in the incubator at 37^{0}c for 24hours.
8. No gas production was noticed after 24 hours. It was then incubated for additional 24 hours to confirm coliform group of bacterial.
9. Results of colony formed per ml were recorded using colony counter machine.
10. The sample was left for 8 days to monitor the growth of yeast/mould (using the same serial dilution) and colony formed was recorded.

3.5.4 Determination of Taste / Odour

The determination of taste and odour was done by six assessors using mouth feel.

1. A little paste (Akamu) was prepared after confirming its safety for consumption (no gas produced or isolation of coliform bacteria) using odour free water.
2. Some quantities of paste-like sediment were stirred in cool water into solution.
3. Hot water (boiling water) was then added to the solution and stirred properly.
4. A thin gruel (porridge) was produced.
5. Little quantity was served to be tasted by the assessors. Also the vapour coming out from the porridge was sniffed repeatedly to observe any odour.

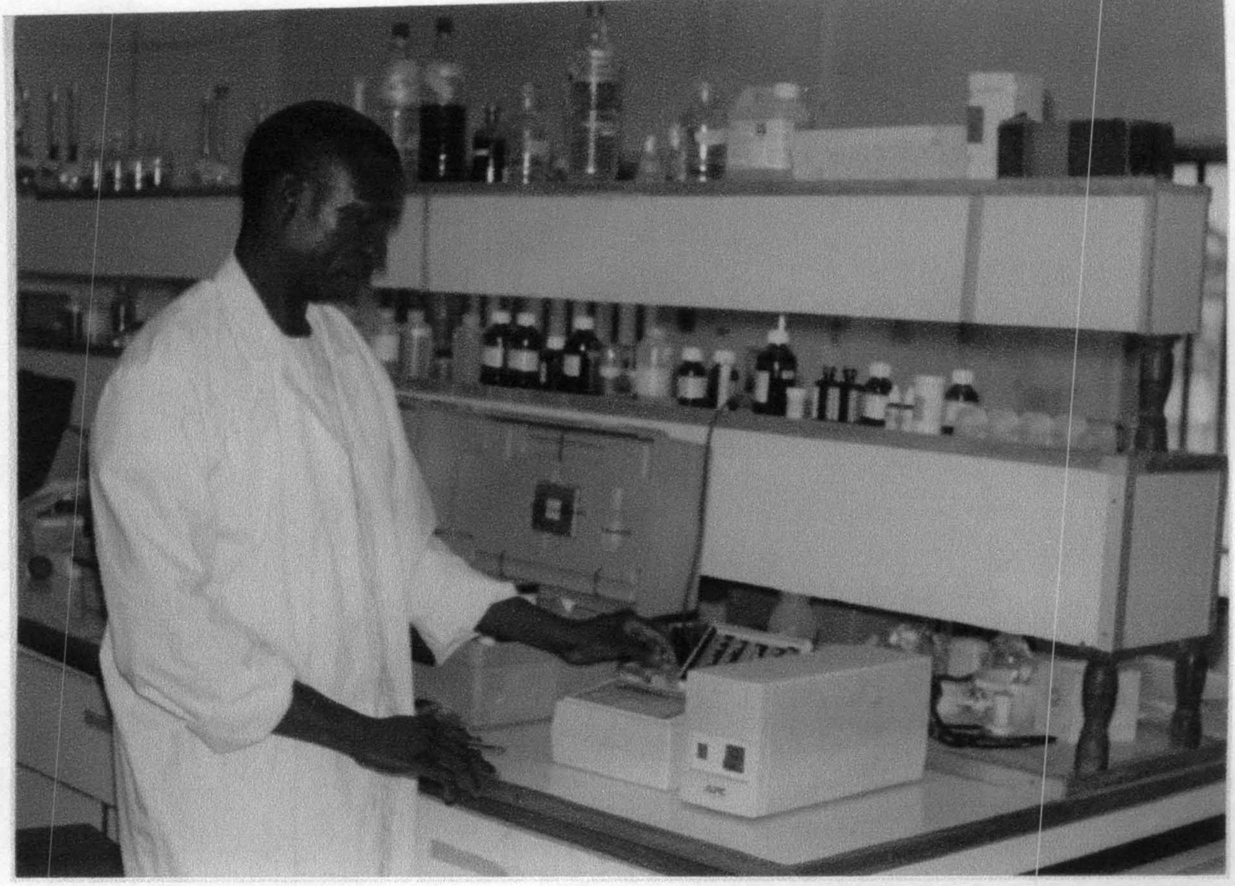

PLATE 1: DETERMINATION OF CHEMICAL PARAMETERS OF THE SAMPLES

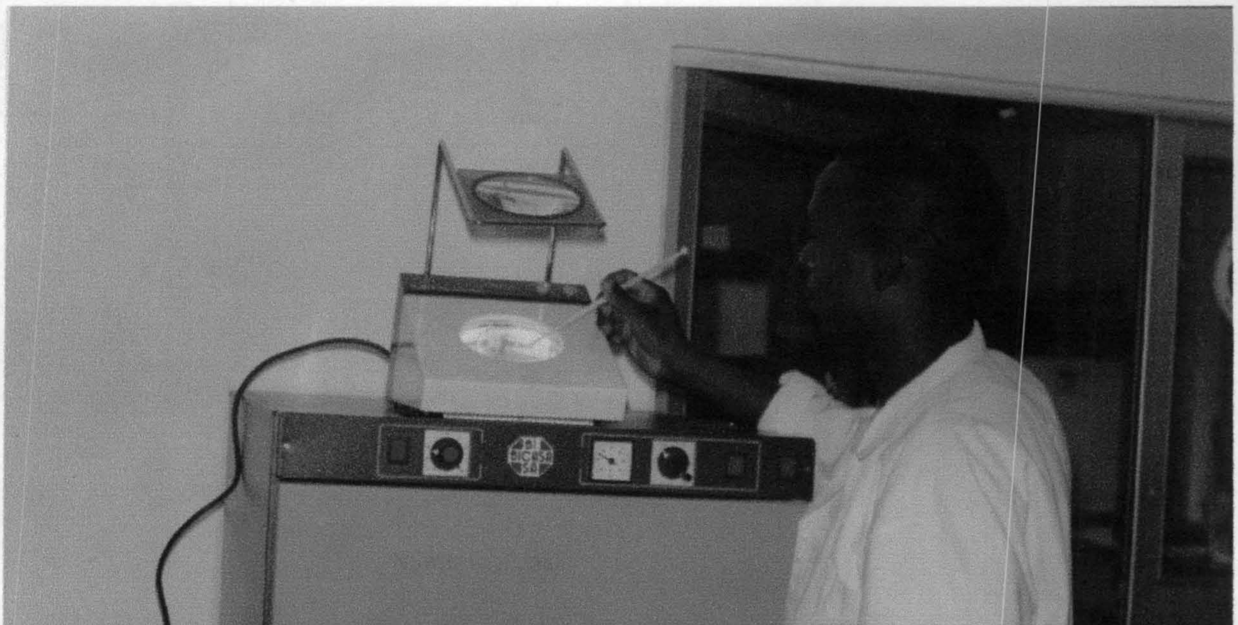

PLATE 2: COUNTING OF MICROBIAL COLONY FORMED

CHAPTER FOUR

4.0 RESULTS AND DISCUSSIONS

4.1 Presentation of Results

The samples were analyzed using standard analytical technique developed by American Public Health Association (APHA), European Community Drinking Water Standard and World Health Organization (WHO)/Food and Agricultural Organization (FAO) of United Nations. (Guideline for drinking water quality Vol. 1 1983)

The results of the analysis are presented in the table below.

TABLE 4.1 PHYSICAL PARAMETER OF WATER ANALYSED

PARAMETER	TAP WATER (A)	WELL WATER (B)	RAIN WATER (C)	STANDARD	
				WHO	EC
P. H.	6.8	6.8	7.04	6.5-8.5	6.5-8.5
Temperature (^{0}c)	21.0^{0}C	23.0^{0}C	20.0^{0}C	N/A	25
Suspended Solids (mg/l)	0.0	3.0	0	N/A	N/A
Total Dissolved Solids (mg/l)	43.0	147.9	06.1	1000	1500
Turbidity (FTU)	0	3	2	5	10
Conductivity (µs/cm)	85.9	290	11.7	N/A	400
Taste	Unobjectionable	Unobjectionable	Unobjectionable	Not Objectionable to 90% Consumers	
Odour	Not offensive Unobjectionable)	Not offensive (Unobjectionable)	Not offensive (Unobjectionable)		
Colour (PtCo)	4	13	2	15	20

(mg/l) = Milligram per litre

µs/cm = Microsiemens per centimeter

F.T.U. = Formazin turbidity Unit

PtCo = Platinum Cobalt

TABLE 4.2 CHEMICAL AND ORGANIC PARAMETER OF WATER

PARAMETER	TAP WATER (A)	WELL WATER (B)	RAIN WATER (C)	STANDARD	
				WHO	EC
Calcium (mg/l)	0.01	0.28	0.07	N/A	100
Magnesium (mg/l)	0.27	0.10	0.01	30	50
Total Hardness (mg/l)	0.28	0.38	0.08	500	N/A
Sulphate (mg/l)	50	71	65	400	250
Iron (mg/l)	0.01	0.10	0.11	0.3	0.2
Phosphate (mg/l)	0.05	0.08	0.0003	N/A	0.5
Nitrite (mg/l)	0.039	0.030	0.017	1.0	N/A
Dissolved Oxygen(mg/l)	3	6	2	N/A	5
Nitrate (mg/l)	7.91	9.20	6.32	10	25

TABLE 4.3 SENSORY PARAMETER OF AKAMU

PARAMETER	SAMPLE (A)	SAMPLE (B)	SAMPLE (C)
TEXTURE (Hand feel and sight)	Firm and Soft Stickness, Powdery	Firm and Soft Stickness,	Firm, Softness & Powdery (dry)
TASTE (Mouth feel)	Creamy, Tasteless	Tasteless & Creamy	Tasteless & Creamy
ODOUR	Not Offensive	Not Offensive	Unobjectionable
COLOUR	Red	Light Red	Light Red

TABLE 4.4 BACTERIOLOGICAL ANALYSIS

PARAMETER	SAMPLE (A)	SAMPLE (B)	SAMPLE (C)	FAO STANDARD
Aerobic plate count (APC) (cfu/ml)	18.0×10^3	15.0×10^3	15.0×10^3	52×10^3
Feacal Coliform (E. Coli) Number/100ml	NIL	NIL	NIL	
Mould/Yeast cfu/ml	$<3 \times 10^2$	$<3 \times 10^2$	$<1 \times 10^1$	$10^2 - 10^4$

NB: cfu/ml = colony forming unit/ml

4.2 DISCUSSION

Tables 4.1, and 4.2 show the result obtained for physical and chemical analysis of the three sources of water (i.e. Rainwater, Tap water and Well water) used to process the Akamu.

Total dissolved solids were found to be higher in the Well water (147.9 mg/l) but fall within the World Health Organization Standard of 1000mg/l. Conductivity in Well water was highest (290 µs/cm) and least in Rain water (06.1 µs/cm) but all met the World Health Organization Standard (2004) of 400us/cm. Taste and Odour were unobjectionable and odour free in the three samples. Tap water had the highest platinum cobalt number of 4, Well water 3 and rain water had 2 PtCo which all met the WHO and European Community Standard of drinking water quality of 15 PtCo and 20 PtCo respectively.

Total hardness was found to be within the WHO standard of 500mg/l in all the samples, but the Well water was the highest (0.38mg/l) as can be seen in Table 4.2. Iron contents in the samples were 0.01 mg/l for Tap water, 0.1mg/l for Well water and 0.11mg'l for Rain water which were within the W.H.O Standard of 0.30mg/l for drinking water (portable water). The pH ranges from 6.8 for Tap water, 6.8 for Well water and 7.4 for Rain water and were within the W.H.O Standard of 6.5-8.5.

4.2.1 Texture

Texture is the attribute of a substance resulting from a combination of physical properties and perceived by the senses of touch (including mouth feel). Pigott (1988). The three samples of Akamu have firm, soft and a little bit sticky texture when rubbed between the fingers when moist (wet). The dry samples have powdery texture when rubbed between the fingers. But slightly gritty in the sample produced from Well water. This may likely be a result of dissolved solids or improper wet milling (grinding) and sieving.

4.2.2 Taste/Odour

The combined perception of substances detected by the senses of taste and smell is often called "taste". Odour and taste are due mainly to the presences of organic substances, increased biological activity and pollution. The samples of Akamu prepared taste slightly creamy, less sugary and no sour taste. The three samples also had unobjectionable/unoffensive odour. This may be as a result of absence of organic impurities in the water used. Also, the low level of dissolved salts (e.g. magnesium, calcium, sodium etc) in the water made the taste unobjectionable.

4.2.3 Microbial Load

The feacal coliform levels in the three samples were 0/10ml which agrees with the WHO standard of less than one (i.e. 0). The aerobic (total) plate count (APC) of the bacteria show the following 18.0×10^3 cfu/ml, 15.0×10^3 cfu/ml for samples produced from Tap water, Well water and Rain water respectively. These results fall within the F.A.O (1992) standard for products requiring heating to boiling before consumption, which is 10^5 cfu/g. It was observed that colony forming unit/ml was highest in the sample with Tap water.

4.2.4 Keeping Quality

Keeping quality is concerned with the shelf life of the samples (Akamu). After keeping for 8 days, the following were observed. The textures of the samples were less sticky and a little slippery/draw in the samples prepared from Tap water and Well water. This may be as a result of increased microbial activities.

The colour at the time of production of the Akamu show the following: Red and light red for that produced from tap water, rain water and well water respectively.

There was a slight change in the colour after 8 days showing light red in all the samples. This may be as a result of slight portion of the Iron content present in the water samples.

Sample of Akamu processed with well water have highest growth of mould (less than $3x10^2$ colony forming unit per milliliter. The growth in samples (A) (Akamu processed with rain water) had the least growth of mould (<1 $x10^1$ cfu/ml). These results agreed with the FAO Standard for cereals product

(10^2 – 10^4). The growth will eventually increase if the product is stored for longer period of time and eventually will result to spoilage and deterioration.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusion

The results of the physical analysis clearly indicated that the well water had highest suspended and total dissolved solids, highest turbidity of 3 FTU and highest conductivity of 290 µs/cm. These results however fell within the impose Standard by various health agencies and organizations but at the point of the limit. The colour in the well water was 13 PtCo almost close to the limit of 15 PtCo guideline set by W.H.O 1984.

A critical looks at the above shows that the higher turbidity will stimulate the growth of bacteria and exert a significant chlorine demand in terms of treatment/disinfections. Higher conductivity is a function of amount of dissolved salts, thus the well water contained more of the dissolved salts than the other samples. Total hardness is lest in the rain water and most in the well water. All the three water samples and Akamu samples had unobjectionable taste and odour. The iron content was lest in the tap water (0.01mg/l) and most in the rain water (0.11mg/l). This may be due to collection method but all were within the standard guideline.

Bacteriological analysis revealed that the samples of water used and the product obtained (Akamu) did not contain any micro-organisms known to be pathogenic. Micro-organisms however exist every where in the air, water, soil and environment. Fresh and processed foods are often spoilt by activity of micro-organisms present in food most of which are bacteria (including fungi like mould and yeast). The results of the analysis indicated that there were higher growths of mould after storing for eight days, which may be as a result of low temperature of the room or the characteristic of the sorghum itself.

The texture of the Akamu became less sticky, and less firm after eight days which may be as a result of microbial activity.

In summary, good quality water, good and well cleaned grains will enhance good Akamu. The result of both the physical and chemical analysis indicated that Tap water and Rainwater were better than the Well water in processing Akamu. This is because the Well water contained highest total dissolved solids, highest conductivity, total hardness, highest nitrate level and highest suspended solids. Also the Well water had the highest dissolved Oxygen level of 6 which will enhance the rapid growth of micro-organisms which will in turn give off flavour and adversely affect the shelf life of the Akamu. The result of the analysis of all the samples however fell within the World Health Organization and Food and Agricultural Organization Standard.

5.2 Recommendations

From the results of the analysis obtained, the following recommendations were made to obtain good quality product (Akamu).

- Periodical examination of microbiological levels in the water used for processing of Akamu. This is to ensure its sanitary quality and its suitability for general use.
- Physical and chemical analysis of well water should be done periodically. This is to ensure that the well water is not polluted or contained doubtful colour or poisonous chemicals that are harmful to man.
- Dug well for domestic use should be covered to protect it from pollution and should be far away from any toilet/latrine to avoid feacal pollution.
- Grains use for Akamu should be free from dirt, impurities or any foreign materials. This is to enhance good coloured Akamu that is free from taste and odour.
- Rain water should not be collected directly from the Zinc (e.g. rusty Zinc). This is to prevent collection of dissolved Zinc particles in the water.

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APPENDIX 1

<u>SOME EXAMPLES OF WORLD HEALTH ORGANISATION GUIDELINES FOR DRINKING WATER QUALITY (1984)</u>

CHARACTERISTIC	**UNIT**	**GUIDE LEVEL**
Chromium	Mg/l	0.05
Lead	“	0.05
Nickel	“	0.001
Nitrates	“	10 as N
Calcium	“	100
Chloride	“	250
Copper	mg/l	0.05
Iron	mg/l	0.3
Magnesium	“	30
Sulphate	“	400
Total dissolved solids	μs/cm	1000
Conductivity	mg/l	N/A
Total hardness as $CaCO_3$	PtCo	500
Colour		15
Odour		Not objectionable to 90% of
Taste	Mg/l	Consumers
Suspended solids	FTU	N/A
Turbidity		5
PH		6.5 – 8.5
Colifirms		Absent in 100ml

Guidelines for drinking water quality, WHO, Geneva, 1983

F.T.U. = Formazin Turbidity Unit

P_tC_o = Platinum Cobalt (or true Colour Unit (TCU)

N/A = Not Available

APPENDIX 2

SOME EXAMPLES OF WORLD HEALTH ORGANISATION GUIDELINES FOR DRINKING WATER QUALITY

CHARACTERISTIC	UNIT	GUIDE LEVEL
Chromium	Mg/l	0.05
Cyanide	"	0.01
Lead	"	0.5
Mercury	"	0.001
Nitrates Nitrogen	"	10
Nitrite Nitrogen	"	1.0
Sulphate	"	400
Copper	"	1.0
Hardness as $CaCO_3$	"	500
Total dissolved solids	"	1000
Sodium		200
Conductivity	µs/cm	N/A
Turbidity	FTU	5
Colour	P_tC_o	15
PH		6.5-8.5
Dissolved Oxygen	Mg/l	5
Colifirms		Absent in 100ml
Taste		Not objectionable to 90% of
Odour		Consumers

Source: Guidelines for drinking water quality, WHO, Geneva 1984