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PREVALENCE AND ANTIBIOTICS SUSCEPTIBILITY PROFILE OF METHICILLIN-RESISTANT *STAPHYLOCOCCUS AUREUSAMONGST TERTIARY SCHOOL STUDENTS*IN ADO-EKITI

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ABSTRACT

This study was carried out to determine the prevalence of community acquired methicillin-resistant Staphylococcus aureus (CA-MRSA) among students attending Ekiti State University and Federal polytechnic Ado-Ekiti. A total of 379 samples were collected from the students' hands, ears, nares and armpits using sterile swab sticks and screened for the presence of S. aureus infection using standard microbiology techniques. MRSA positive isolates were detected phenotypically using cefoxitin disc (30µg). The modified iodometry method was used in the detection of β-lactamase and genes detected by the Polymerase Chain Reaction (PCR) technique. Statistical analysis was performed using Statistical Package for Social Sciences (SPSS) for windows version 22 and association between the variables was determined using chi-square with level of significance set at P≤0.05. Antibiotics resistance was determined by the disc diffusion methods using gentamycin, ofloxacin, vancomycin, streptomycin, erythromycin, tetracycline, penicillin & chloramphenicol according to the CLSI. Out of the 379 samples used, 259 (63.3%) isolates were S. aureus and 37 (14.3%) isolates were MRSA. Male students have higher occurrence of S. aureus than their female counterparts. The MRSA isolates were resistant to penicillin (100 %), followed by vancomycin (48.6 %), tetracycline (37.8 %), erythromycin (32.4 %) and chloramphenicol & streptomycin with 24.3% each. A total of 11 of the 37 MRSA isolates showed multiple drug resistance (MDR). Out of the 37 MRSA isolates used for the PCR analysis, 18 (78.3%) possess nuc gene while 19 (82.6%) possess mecA gene and 8 (34.8%) for coagulase gene. Public enlightenment to promote rational use of antibiotics and investigation of MRSA infection from all settings will be ensured in order to contain the emergence and spread of such pathogens.

Keywords: Antibiotic resistance, CA-MRSA and PCR.

INTRODUCTION

Colonization and infection of methicillin-resistant *Staphylococcus aureus* (MRSA) in healthy people is on the increase (Peters *et al.,* 2013). A major concern in the treatment of *S. aureus* infection with methicillin is the presence of MRSA strain which may also be referred to as multidrug-resistant *S. aureus* (Hena and Sudha, 2011). *Staphylococcus aureus* especially MRSA is relatively ubiquitous and is the cause of many community and nosocomial infections (Al-baidani *et al.,* 2011; Okwu *et al.,* 2012). Community acquired methicillin-resistant *Staphylococcus aureus* (CA-MRSA) infections which were first defined in small series of adult and infant patients presenting skin and soft tissue infections, pneumonia have become a significant public health threat globally (Peters *et al.,* 2013). CA-MRSA carry the smallest staphylococcal cassette chromosome *mec* (SCC *mec*) type IV and V, that are resistant to fewer antibiotics and are associated to the presence, and enhanced expression of specific virulence factors (Gouveia *et al.,* 2013). The resistance to antibiotics in MRSA is due to the presence of *mecA* gene on staphylococcal cassette chromosome

SCC, which expresses a novel cell wall synthesizing enzyme, penicillin-binding protein 2A (PBP2A) with low affinity for all β-lactams (Al-baidani *et al.,* 2011).CA-MRSA strains are those strains of *S. aureus* that are not acquired from a healthcare setting, but rather developed from the community and without identified risk factors that allowed hospital-acquired MRSA (HA-MRSA) which is nosocomial in origin to emerge (Iroha *et al.,* 2015). There is increasing evidence that CA-MRSA is on the rise in many parts of the world including Nigeria, a country with high population density, where the antibiotic consumption in humans is extremely high. This combination makes a perfect picture for spread of drug-resistant bacteria like MRSA in the community. Therefore, the aim of this study was to determine the prevalence and antibiotics susceptibility profile of methicillin-resistant *Staphylococcus aureus* amongst tertiary school students in Ado-Ekiti, Ekiti State, Nigeria.

MATERIALS AND METHODS

Specimen

A total of 379 swab samples were collected from the apparently healthy students of the Ekiti State University, Ado-Ekiti and The Federal Polytechnic, Ado-Ekiti with their ages ranging from 16 to 28 years. The swab samples were randomly collected from the students by swabbing their nares, armpits, hands, ears, with sterile swab sticks moistened in physiological saline. All swab sticks were returned to their containers; and the samples were to the laboratory for analysis within 1 hour of collection. They were analyzed using standard methods (CLSI, 2020).

Bacteriology

Each of the swab samples were cultured on freshly prepared Mannitol salt agar by streaking with the aid of flamed inoculating loop and incubated at 37°C for 24hours.The isolates on each of the plates were sub cultured onto Mannitol salt, Broth agar and nutrient agar plates to get pure cultures. Characteristic isolates of *S. aureus* on the agar plates were isolated and identified by standard microbiological tests including coagulase test, catalase test, heamolysis teston blood agar and Gram staining (Cheesbrough, 2006).

Detection of MRSA

All the *S. aureus* isolates were subjected to cefoxitin disc diffusion test using a 30µg disc. A 0.5 McFarland standard suspension of the isolates were made and a lawn culture was done on Mueller Hinton agar plate. The plates were incubated at 35°C for 8-24 hours and inhibition zone diameters (mm) were measured. Inhibition zone diameter of $\leq$ 21mm was obtained as methicillin resistant and $\geq$ 22mm as methicillin sensitive (Rasheed and Ahmed, 2010).

Beta-lactamase (Penicillinase) Production Test

B-lactamase production was determined by iodometric strip method. Strips of starch papers were soaked for 10 minutes in a solution of benzyl penicillin (100 IU/ml) and then spread smoothly in a Petri-dish. Each strip was used to test 2 isolates. Test organisms were transferred to the surface of the paper using wire loop (2mm diameter) at about 2 cm apart. The plates were incubated at 37 °C for 30 minutes after which the incubated plates were flooded with Lugol's iodine solution and drained off immediately. Penicillinase-production was manifested by clearing around the organisms on the starch paper, whereas the non-penicillinase producer remained blue black (Odugbemi *et al.* 1977).

Antibiotic Susceptibility Testing

The antimicrobial susceptibility patterns

of the isolates were determined according to Kirby Bauer disc diffusion method (CLSI, 2020). The following 8 antibiotics and concentrations were used to determine the antibiogram of the isolates. They are as follows: Ofloxacin (5µg), penicillin (10µg), cefoxitin (30µg), tetracycline (30µg), chloramphenicol (30µg), gentamyc in (10µg), erythromycin (15µg), streptomycin (10µg) and vancomycin (30µg). Disc of the respective antibiotics was aseptically placed on the surface of the pre-inoculated agar plates using sterile forceps. Thorough contact of the discs with the agar was ensured by pressing the discs firmly but carefully on the plate with sterile forceps. Culture plates were allowed to stand for 5 minutes to allow the antibiotics to diffuse into the agar medium and subsequently incubated at 37 °C for 24 hours (Cheesbrough, 2006).Antibiotic susceptibility patterns were indicated by the zone of inhibition around each disc. The diameter of the zone of inhibition produced by each antibiotic disc was measured and recorded as resistant, intermediate or sensitive based on the standard interpretative chart according to the CLSI (2020). Multidrug resistance was defined as resistance to four or more of the antibiotics tested.

Statistical Analysis

Statistical analysis of data was done using Statistical Package for Social Sciences Version 22.0. Associations between the variables were determined using Chi-square with level of significance set at p □0.05.

DNA Isolation

DNA isolation was carried out according to Shittu and Lin (2006).

PCR Amplification of *nuc*, *mecA*and *coag*genes

Polymerase chain reaction (PCR) was used to detect *nuc,mecA*and*coag*genes in *methicillin-resistant Staphylococcus aureus (MRSA) isolates*. For the PCR, 25 µl of 2X PCR Master Mix (Norgen Biotek Corp. Ontario, Canada) is a ready-to-use solution that contains components such as Taq DNA polymerase, dNTPs, reaction buffer, $MgCl_2$, KCl and PCR enhancer which was added into the PCR tube of 50 µl as recommended by the manufacturer of the 2X PCR Master Mix.Template DNA and nuclease-free water were also added into the PCR tube to bring the total volume to 50 µl. The PCR mixture was thoroughly mixed and spun down momentarily. The PCR tubes were placed into thermocycler (Hybaidomnigene, UK) as recommended by the Master Mix manufacturer in PCR cycle conditions consisting initial denaturation at 95°C for a cycle in 2 minutes, 30 cycles of denaturation at 95°C for 30 seconds, annealing temperature ramped at 55°C for 30 seconds, extension at 72°C for 30 seconds and final extension at 72°C for a cycle in 5 minutes. A 10 µl aliquot of PCR reaction was mixed with 2 µl of loading dye (6X) and loaded on a 1.5% (w/v) agarose gel for visual evaluation by using ethidium bromide under a UV transilluminator. The primer sequences used for the genes are *nuc*-1 GCAAATGCATCACAAACAGG, *nuc*-2 AATGCACTTGCTTCAGGACC, *mecA*-1 CCCAATTTGTCTGCCAGTTT, *mecA*-2 TCAGGTTACGGACAAGGTGA, *coa*-1 GAAACAAGAGAAGCGGTTG, *coa*-2 TCTTCAGCTTTACCAGCCGT. The molecular weight of the entire *nuc*,*mecA*and *coag*genes was estimated using a 1 kb ladder on agarose gel electrophoresis.

Ethical considerations

Consent was obtained from the participating students attending the two Institutions prior to the collection of samples.

Results

Out of the 379 samples collected from the students, 259 (63.3%) isolates were confirmed as *S. aureus.* The distribution of *S. aureus* in the different samples investigated shown that the highest occurrence (34.4%) was from hand samples, followed by ear (23.9%), nare (21.6%), while the least was from armpit (20.1%) as shown in figure 1. Male students have higher occurrence of *S. aureus* than the female counterparts (figure 2). However, the highest number of *S. aureus* 120 (46.3%) were isolated from the age group of 21-25 years, followed by age group of 16-20 years and least in the age group of 26-30 years as shown in figure 3.Table 1 also shows the rate of isolation of MRSA and β-lactamase producing isolates from the samples. Out of the 259 isolates of *S. aureus* obtained, 37 (14.3%) isolates were MRSA and 16 (43.2%) isolates were positive for beta-lactamase production. The result of antimicrobial susceptibility studies conducted on all confirmed MRSA positive bacteria isolates are shown in Table 2. The MRSA isolates were resistant to penicillin (100%),with less resistance in vancomycin (48.6%), followed by tetracycline (37.8%), erythromycin (32.4%) and chloramphenicol & streptomycin with 24.3% each. A total of 11 of the 37 MRSA isolates showed multiple drug resistance (MDR). Table 3 above shows that 7 MRSA isolates were resistance to 4 agents while 3 MRSA isolates were resistance to 5 agents and 1 MRSA isolate was resistance to 6 agents. In the finger prints for *nuc*, *mecA* and *coag* genes, in Fig 5, 6 and 7, the bands were read accordingly. The lanes that showed the genes were indicated whereas the lanes that are blank were also indicated. Out of the 37 MRSA isolates used for the PCR analysis, 18 (78.3%) possess*nuc* gene while 19 (82.6%) possess *mecA*gene and 8 (34.8%) for coag gene.

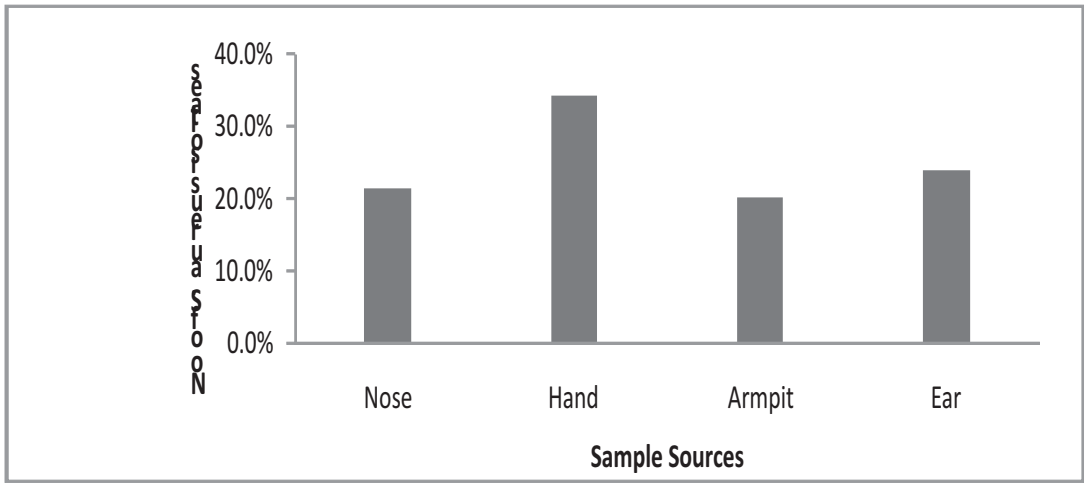

Figure 1Distribution of *S. aureus* isolates according to sources

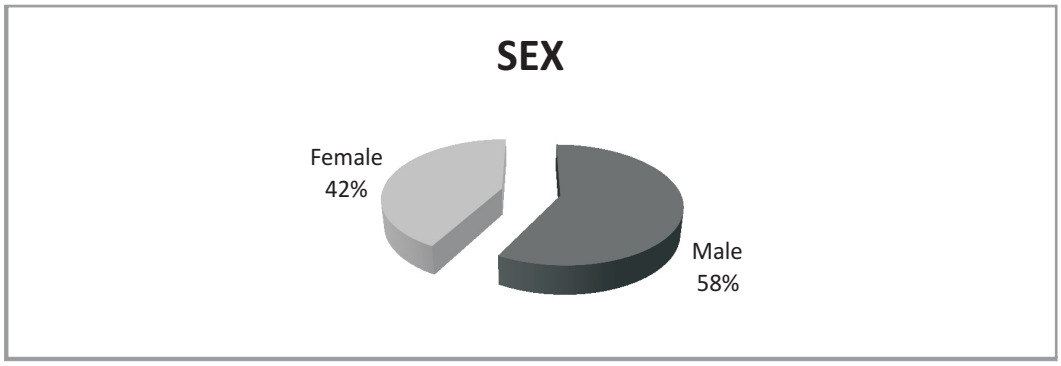

Figure 2: Distribution of *S. aureus* isolates according to sex

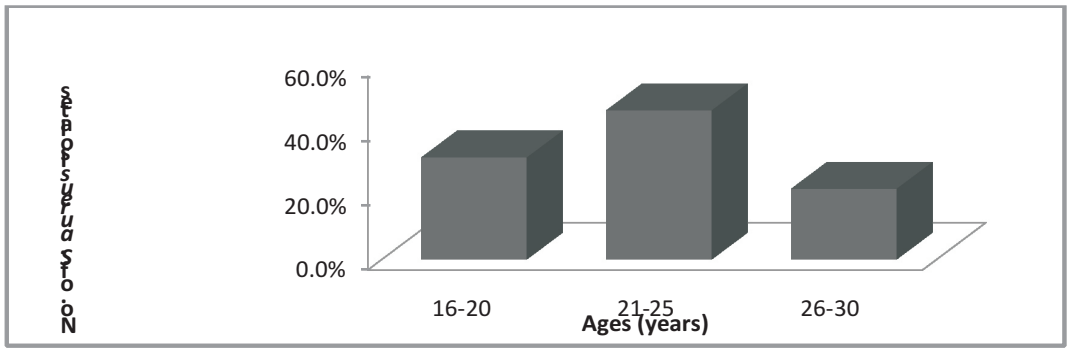

Figure 3: Distribution of *S. aureus* isolates according to ages

Table 1:Distribution of MRSA and beta-lactamase producing isolates from different sources

SAMPLE SOURCE	MRSA NO (%)	SEX (%)		PENICILLINASE NO (%) / SEX (%)					
		M	F	Negative	M	F	Positive	M	F
Nose	5 (13.5)	2 (9.5)	3 (18.8)	1 (4.8)	0 (00.0)	1 (9.1)	4 (25.0)	2 (20.0)	2 (33.3)
Hand	13 (35.1)	12 (42.9)	4 (25.0)	6 (28.6)	3 (30.0)	3 (27.3)	7 (43.8)	4 (40.0)	3 (50.0)
Armpit	11 (29.7)	6 (28.6)	5 (31.3)	8 (38.1)	3 (30.0)	5 (45.5)	3 (18.8)	3 (30.0)	0 (0.0)
Ear	8 (21.6)	4 (19.0)	4 (25.0)	6 (28.8)	4 (40.0)	2 (18.2)	2 (9.5)	1 (10.0)	1 (16.7)
Total	37 (100)	21 (56.8)	16 (43.2)	21 (100)	10 (47.6)	11 (52.4)	16 (100)	10 (62.5)	6 (37.5)

Table 2: Result of susceptibility of MRSA positive bacteria to antibiotics

Antibiotics (µg)	Sensitive No (%)	Intermediate No (%)	ResistanceNo (%)
Gentamycin (10)	34 (91.9)	2 (5.4)	1 (2.7)
Ofloxacin (5)	36 (97.3)	0 (0.0)	1 (2.7)
Streptomycin (10)	26 (70.3)	6 (16.2)	9 (24.3)
Chloramphenicol (30)	23 (62.2)	5 (13.5)	9 (24.3)
Erythromycin (15)	9 (24.3)	16 (43.2)	12 (32.4)
Tetracycline (30)	10 (27.0)	13 (35.1)	14 (37.8)
Vancomycin (30)	19 (51.4)	0 (0.0)	18 (48.6)
Penicillin (10 IU)	0 (0.0)	0 (0.0)	37 (100.0)

Table 3: Prevalence of multiple antibiotic resistance amongst 11 MRSA isolates

Parameter	Frequency of multidrug resistance	Percentage
Fully sensitive	0	0
Resistance to 4 antibiotics	7	63.6
Resistance to 5 antibiotics	3	27.3
Resistance to 6 antibiotics	1	9.1

Figure 4: Finger prints for *nuc* genes

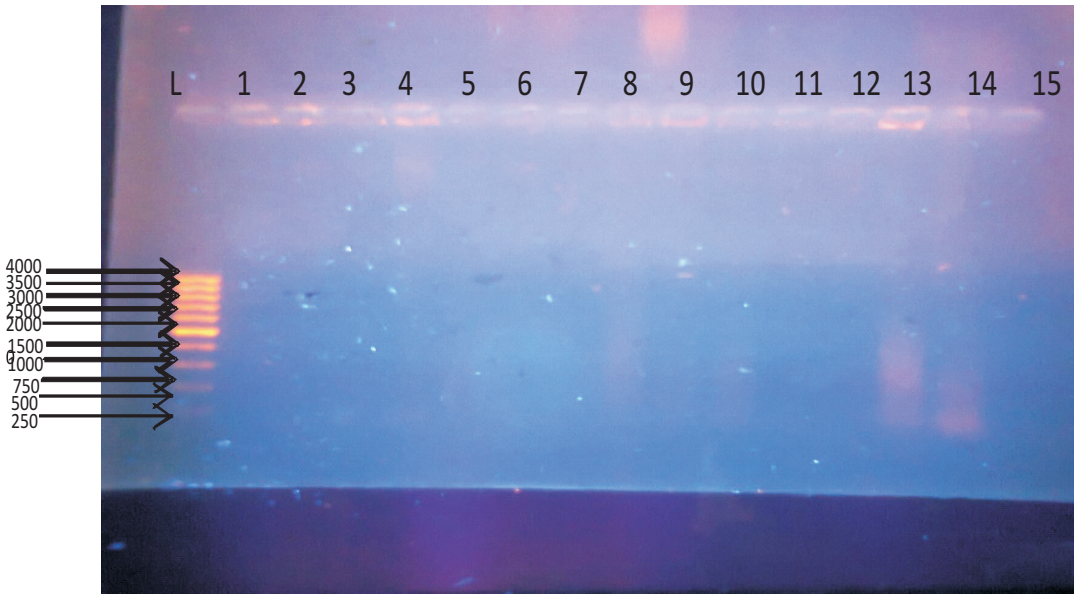

Figure 5: Finger prints *mec A* genes

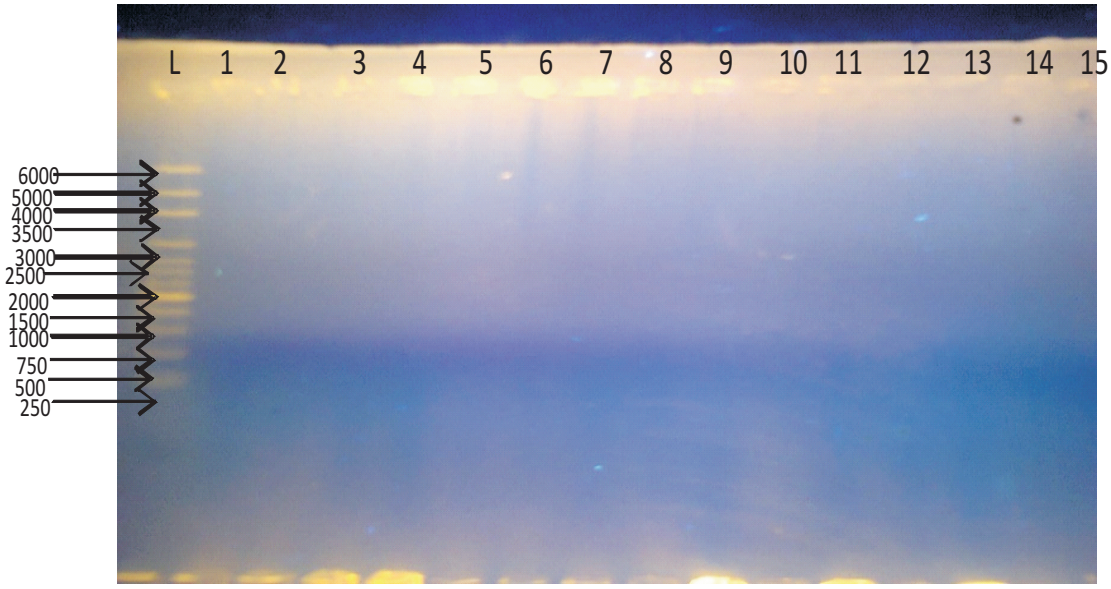

Figure 6: Finger prints for coag genes

Discussion

The frequency of isolation of *S. aureus* from students attending tertiary schools was 63.3%. The frequency of *S. aureus* isolation was highest from hand samples studied with 34.4% among the subjects. Male students had the highest (57.9%) compared to female students(42.1%). The sex related prevalence depend on the level of hygiene and general sanitation of the subjects. This observation agrees with the study reported by Umanu *et al.* (2013). The highest number of *S. aureus* 120 (46.3%) were isolated from the age group of 21-25 years. However, the result obtained in this study was slightly different from that of Okwu *et al.* (2014), who showed that *S. aureus* prevalence rate were highest in the age group of 9-14 years with 18.6%, followed by 3-8 years with 17.2%, then15-19 years with 10.6%.In this study, the increasing level of MRSA with 14.3% agrees with a study in North-Eastern Nigeria with a prevalence of 12.5% (Okon *et al.,* 2013). It also comes close to a report of Kejela and Bacha, (2013) who reported MRSA prevalence rate of 18.8% among primary school children aged 5-15years.In Abia and Ebonyi State, South-East Nigeria, the prevalence of CA-MRSA were 83.5% and 43.4 %respectively due to high occurrence in the study population (Ugbogu *et al.,* 2010; Iroha *et al.,* 2015).

Similarly, Vasquez *et al.* (2015) reported 19 (25%) MRSA isolates among students at a small Southern University Kingsville Texas which suggested that indirect transmission played role in the spread of these pathogens. In Imo State, Southeast Nigeria, Amadi *et al.* (2013) reported a prevalence rate of 27 % of *S. aureus isolates* that were methicillin-resistant which were high in occurrenceamong studies population. Okwu *et al.* (2014)reportedlow prevalence rate of 25 (6.9%) CA-MRSA strains among healthy individuals in Okada, South-South, Nigeria. In addition, Habeeb *et al.* (2014) reported the prevalence level of MRSA nasal colonization of 10 (2.04%) among secondary school students at Duhok City-Iraq. The penicillinase producing ability of MRSA isolates from subjects of tertiary schools in this study was 43.2%.Individuals who are carriers can spread resistant strains among themselves through direct or indirect but it is worse among student carriers because they always come in close contact especially in hostel accommodation and during other student activities. The MRSA isolates were resistant to Penicillin (100 %), with less resistance in vancomycin (48.6 %), followed by Tetracycline (37.8 %), Erythromycin (32.4 %) and Chloramphenicol & Streptomycin with 24.3% each.In the study conducted by Kaur *et al.* (2014), CA-MRSA strains shows less resistance against Tetracycline, Rifampicin, Clindamycin and no resistance to Vancomycin. A total of 11 of the 37 MRSA isolates showed multiple drug resistance (MDR).Similarly, Ibe *et al.* (2013) reported 10 (100%) CA-MRSA isolates are resistance to more than 4 antibiotics and antibiotypes shows about 60% of MRSA isolates were resistant to 4 and 6 antibiotics. 20% were resistant to 5 and 7, and while 20% were resistant to 8 antibiotics used. Out of the 37 MRSA isolates used for the PCR analysis, 18 (78.3%) possesses*nuc* gene while 19 (82.6%) possess *mecA* gene and 8 (34.8%) for coagulase gene.This finding agrees with the report of Chikkala *et al.,* (2012) who observed that out of the 54 isolates, 29 (53.7%) showed the 270bp *nuc* that included 52% MRSA and 48% MSSA.Medeiros *et al.* (2015) reported18.6% of *mecA* gene which is lower than this finding.Five MRSA isolates possess all the 3 genes detected in this study and three MRSA isolates possess

the combination of *mecA* and *nuc* genes. In addition, 17 MRSA isolates possess the combination of coagulase and *mecA* genes.

Conclusion and Recommendation

The increasing level of MRSA in the study areasmight be related to the abuse of antimicrobial agents as wells as possible poor personal hygiene. Multidrug resistance in the MRSA isolates to antibiotics was observed indicating the indiscriminate use of antibiotics in the study areas.Health education to promote rational use of antibiotics and investigation of MRSA infectionin the study area is recommended in order to reduce the emergence and spread of resistance *S. aureus*.

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EVALUATION OF THE ACTIVITY OF BREADFRUIT (*Artocarpus altilis*) AMYLASE

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Abstract

The ability of breadfruit amylase to survive the drying temperature during the processing of breadfruit into flour and cause degradative changesin the quality of the flour during storagenecessitated this study. The activity of breadfruit amylase as affected by temperature, pH, substrate concentration, microwave radiation and disodium ethylenediamine tetraacetic acid (EDTA) was investigated. Crude amylase was extracted from breadfruit and its activity under the influence of temperature (40°C to 90°C), pH (3. 5 to 8.0), substrate concentration (100 to 1000 µg),microwave radiation (2450 Hz, 800W, 30 seconds), and EDTA (10mM), was evaluated using standard procedures. Thermal stability of the crude enzyme at 40°C and 90°C, and the specific activity of alpha and beta amylases of breadfruit werealso determined using standard methods.Crude amylase enzyme extract of breadfruit had enzyme activity of 3.95 units/mL, which was reduced to 2.91 units/mL and 2.30units/mL by microwave radiation and EDTA respectively. The optimum temperature and pH were 60°C and 6.0 respectively; the enzyme appeared to be thermally stable retaining about 10% of its activity after pre-incubation period of 120 minutes at 90°C. The Vmax and Km were17.99 ***µg/mL/min*** *and526.32* ***µg/mL respectively. Specific alpha amylase activity and beta amylase activity were*** *7.65units/mg and 5.14units/mg respectively indicating that alpha amylase activity was prominent in breadfruit starch hydrolysis.A pH below 3.50, microwave radiation and EDTA may be employed during the processing of breadfruit into flour to reduce the undesirable amylase enzyme activity during breadfruit flour storage.*

Keywords: *Breadfruit, amylase activity, EDTA, microwave radiation, pH, thermal stability*.

INTRODUCTION

Metabolic processes during ripening of breadfruit are very high resulting in rapid ripening and deterioration of the fruit after harvesting. One of such processes is carbohydrate breakdown; there is usually rapid enzymatic conversion of starch to sugar during ripening of the fruit(Jones *et al.,*2011; Worrell *et al.,* 1998; Adewusi *et al.,* 1995).This particular process is a major feature that characterizesthe post harvest spoilage ofbreadfruit. Hence most preservation techniques used on the fruit focused on the control of post harvest hydrolysis of starch to sugarwhich is caused by enzyme. Such methods include low temperature storage, wax coating and controlled atmosphere storage (Worrell *et. al.,* 2002; Jones *et. al.* 2011). Due to inadequacies of these preservation techniques to substantially extend post harvest storage of breadfruit, conversion of the fruit to flour, which can be used in food applications, has been adopted as a way of preserving and expanding the utilizationof the fruit. Breadfruit flour has been mixed with flours from other crops especially wheat and used to produce food products such as bread, biscuit, weaning foods and instant pounded yam product(Oladeji *et al*, 2013;Olaoye and Onilude, 2008; Ijarotimi and Aroge, 2005).The flour has moderate glycemic index and do not contain gluten which suggest its suitability for people

with postprandial hyperglycemiaand celiac disease.However, research has shown that hydrolysis of starch to sugar by breadfruit amylase continued during breadfruit flour storage resulting in rise in sugar content and consequent decrease in the flour water absorption capacity, swelling power and paste viscosity (Mayaki *et al*., 2003).These changes in breadfruit flour properties during its storage limit the storage potential and utilization of the flour. This observation suggests that the inherent amylase enzyme of breadfruit survived the optimum temperature employed for drying breadfruit slices during the production of the flour. There is inadequate information on the activity of breadfruit amylase.The effect of chemical and physical processes leading to reduction in the activity or inactivation of the enzyme will be of utmost importance during breadfruit flour production. In this study the activity of crude breadfruit amylase as affected by microwave radiation, EDTA, temperature, pH, and substrate concentration was investigated.

Methodology

Preparation of Crude Amylase Extract

Crude enzyme was extracted using the method described byAfiukwa *et al.* (2009) and Rao *et al.* (2005). Matured breadfruit previously stored at 4°C for 5 hours was washed with distilled water and peeled with stainless knife; the core of the fruit was removed and the pulp was diced. Breadfruit pulp pieces (40 g) were homogenized in an electric blender for 10 minutes with 120 mL of 20 mM sodium acetate buffer (pH 5.5, at4°C) containing 0.02 M calcium chloride (as stabilizing agent). The homogenate was filtered through two layers of muslin cloth previously washed with sodium acetate buffer (pH 5.5) and then centrifuged at 4000 rpm for 10 minutes at 4°C in a Harrier benchtop centrifuge (Harrier 18/80R; MSE (UK) Ltd.). The supernatant obtained after centrifugation was collected as crude enzyme extract and preserved at 4°C.

Crude Amylase Activity Assay

Total Amylase activity of the crude extract was evaluated by using iodine method of Fuwa (1954) as described by Sodhi *et. al.* (2005). Soluble starch was used as substrate. The reaction mixture consists of 1 mL of crude enzyme extract, 5 mL of 1% soluble starch in 20 mM sodium acetate buffer (pH 5.5) containing 0.02 M calcium chloride. The mixturewas incubated in a Gulfex incubator (DNP 9082-1; Gulfex Medical and Scientific Ltd., England) at 40°C for 10 minutes before the reaction was terminated by adding 1 mL 0.1M hydrochloric acid. The reaction mixture (5 mL) and 50 mL of iodine solution (12 mg iodine and 25 mg potassium iodide in 100 mL) was mixed together and the absorbance was read at 620 nm using Jenway spectrophotometer (Model 7315; Bibby Scientific Ltd, UK). The amount of starch hydrolysed was estimated from a standard curve of absorbance against starch concentration. Under this standard experimental condition, one unit of enzyme activity was defined as the activity that hydrolyzed 1µg of starch per minute.

Effect of Temperature and Thermal Stability

The effect of temperature on the amylase activity was evaluated in 20 mM sodium acetate buffer (pH 5.5) by varying the incubation temperature of the reaction from 40°C to 90°C at 5°C interval. Thermal stability of the crude enzyme extract was determined at 40°C and 90°C. The enzyme extract was pre-incubated for 120 minutes at temperatures of 40°C and 90°C respectively. At 20 minutes intervals aliquots were withdrawn and immediately cooled to room temperature, residual

enzyme activity was measured under standard condition as previously described(Ahi *et. al.* 2007).The relative activity at each interval of pre-incubation was expressed as follows:

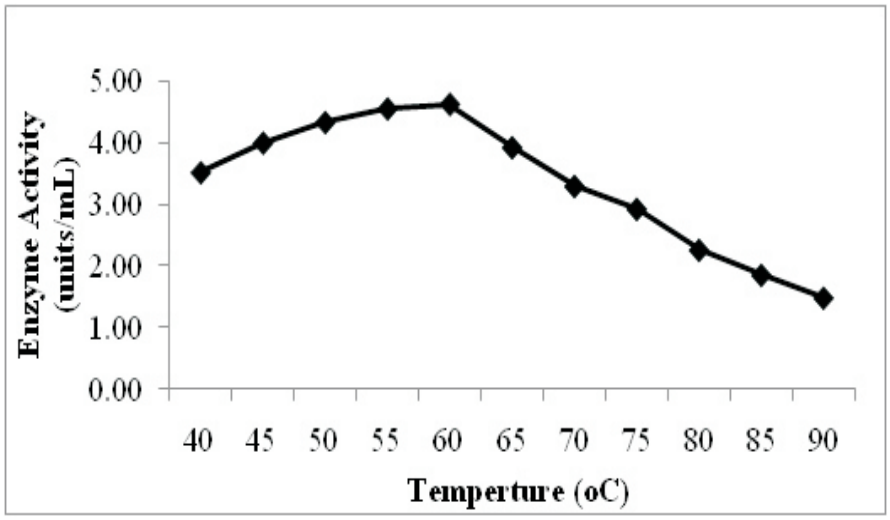

Fig. 1. Effect of temperature on the activity of crude amylase enzyme of breadfruit

The result of thermal stability of breadfruit amylase as presented in Fig. 2 showed that the enzyme is very stable at 40°C. Breadfruit amylase retained more than 97% of its activity after about 120 minutes pre-incubation at 40°C. However, about 90% of the enzyme activity was lost after about 120 minutes of pre incubation at 90°C, a condition that would otherwise have completely inactivated other food enzymes. This agrees with previous reports that the enzyme was not completely inactivated at the drying temperature of 80°C during the production of breadfruit flour (Arinola and Akingbala, 2018; Mayaki *et. al*., 2003). Previous study reported that amylase at high temperatures could exist under a great but finite number of active and stable configurational states(Violet and Meunier, 1989).

Effect of pH

The activity of breadfruit enzyme as influenced by pH is shown in Fig. 3. Enzyme activity initially increased with increase in pH until it reached its maximum (4.52 units/mL) at pH 6.0 after which the activity reduced progressively as pH increased. Change in pH affects the charge and charge distribution on the enzyme, substrate and even co-enzymes (El Nour and Yagoub, 2010). The ability of amino acid side chains in the active site of enzyme to participate in theinteraction which stabilizes protein enzyme structure depends on their state of ionization (Nelson and Cox. 2008). Change in reaction pH which affects the state of ionization of the side chains will affect the stability of enzyme structure. The reduction in activity as pH increased may therefore be due to breaking of bonds that maintain the tertiary structure of enzyme protein which resulted in the change of protein structure (Afiukwa *et. al*., 2009).This might have caused loss of functional structure of the active site of the enzyme such that the substrate would no longer fit into it, hence reduction in enzyme activity.

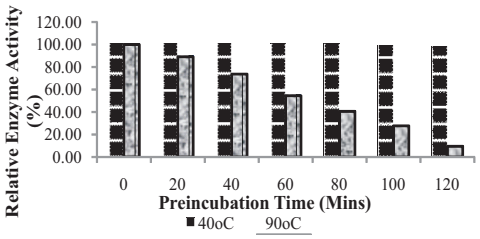

Fig. 2. Thermal Stability of crude amylase enzyme of breadfruit

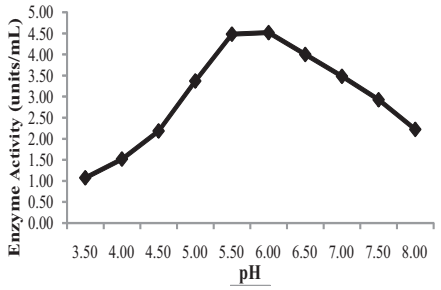

Fig. 3. Effect of pH on the activity of crude amylase enzyme of breadfruit

Change in pH may also affect the charge properties of starch making it difficult for it to bind to the active site of enzyme or undergo catalysis. The effect of pH in reducing enzyme activity may also be explained in terms of availability of calcium ion, a co-factor required for the stability and activity of alpha amylase (Damodaran *et. al*., 2008).Reduction in pH reduced the calcium ion binding sites on the enzyme while increase in pH converts calcium ion to hydroxides, thereby reducing enzyme activity (Muralikrishna and Nirmala, 2005).This may also have contributed to the reduction in activity of breadfruit amylase as pH increased or decreased beyond optimum value. At pH 3.50, the activity of the enzyme was 1.00 units/mL (Fig. 3); this suggests that reducing pH below 3.50 may reduce the activity of the enzyme towards zero, and may be inactivated by the pH of the stomach.

Effect of Substrate Concentration, and the Kinetics Parameters

Increase in substrate concentration increased the enzyme activity up to 14.00 units/ml after which the activity peaked out (Fig. 4); this is probably due to transition of the hydrolytic reaction from unsteady state to steady state. After the reaction rate reached a maximum (steady state), further increase in substrate concentration would have no effect on the reaction rate (Nelson and Cox, 2008). Using soluble starch as substrate, the Vmax (maximum velocity of thereaction) attained by the enzyme and Km (Michaelis constant) as determined from Lineweaver-Burk plot (Fig. 5) were 17.99**µg/mL/min** and 526.32 µg/mLrespectively. The affinity of enzyme for its substrate (Km) shows the substrate concentration when the reaction rate is half maximal. The Km of breadfruit amylase was lower than 2 x 10^{-3} g/mL reported for apple (Kanwal *et. al*. 2004)and 3.3 x 10^{-3} g/mL reported for pawpaw (Annis, 1982); this low Km suggests that breadfruit amylase had great affinity for the starch substrate.

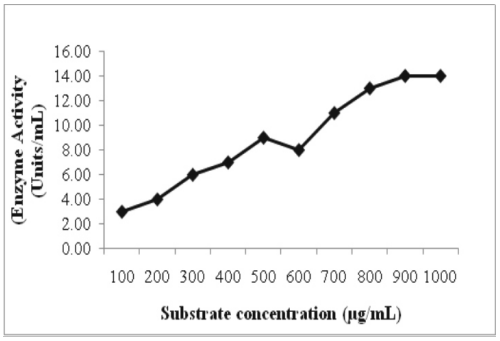

Fig. 4. *Effect of substrate concentration on the activity of crude amylase enzyme of breadfruit*

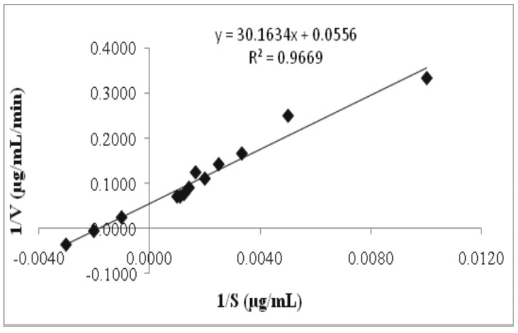

Fig. 5. *Lineweaver-Burk plot of crude amylase enzyme of breadfruit*

Effect of Microwave Radiation and EDTA

Exposure to microwave radiation (2450MHz, 800W) for 30 seconds reduced breadfruit amylase activity from 3.95 units/mL to 2.91 units/mL. Microwave radiation is a non-ionizing electromagnetic radiation that does not carry enough energy per quantum to ionize or completely remove an electron from an atom or molecule (Brasoveanu and Nemtanu, 2014);however,the effect of the electromagnetic field of the radiation on the structure and active site of the enzyme protein may have been responsible for the reduction in the enzyme activity (Latorre*et. al.* 2012).The irradiation induced rearrangement of protein structural organization does not provide enough energy to break covalent bonds in the enzyme protein, but can interfere with the cooperative interactions of bonds within enzyme molecules that form the basis of structure of biological macromolecules. Also the direct transfer between the electromagnetic field and thepolar protein's domains could have reduced the flexibility of the enzyme and consequently the enzymatic properties. Flexibility of the active site of enzymes has been reported to be necessary for catalysis to take place (Shu and Frieden, 2005).

Application of disodium ethylenediamine tetra acetic acid (EDTA) reduced enzyme activity from 3.95units/mL to 2.30units/mL. The EDTA probably caused partial reduction in the activity of breadfruit amylase by chelating calcium ion; calcium ion plays a role in the stabilization of secondary and tertiary structures of amylase especially alpha amylase (Damodaran *et. al*., 2008). Calcium ion also stabilizes the active site of the enzyme by inducing ionic bridge that helps to prevent the unfolding of the enzyme (Muralikrishna and Nirmala, 2005 Violet and Meunier, 1989). Alpha amylase is known to be a calcium metalloenzyme, its activity depends on the availability of calcium ion; unavailability of calcium ion would therefore affect both its activity and stability.

Activity of Alpha and Beta Amylases of Breadfruit

The presence of alpha and beta amylases in breadfruit (Table 1.) shows that both amylases may have been involved in the hydrolysis of breadfruit starch. The extent of the involvement of each enzyme was not determined. However, enzyme activity of crude alpha amylase was 7.63 units/mL while its specific activity was 3.45 units/mL/mg. The specific activity of alpha amylase was higher than that of beta amylase which suggests that alpha amylase activity was prominent in the hydrolysis of breadfruit starch. This is further corroborated by reduction in the viscosity of breadfruit flour paste as a result of continuous amylolytic activity during the storage of the flour (Arinola and Akingbala, 2018; Mayaki *et. al.,* 2003). Alpha amylase causes more rapid reduction in viscosity than beta amylase (Horvathova *et. al.*, 2001).Furthermore the ability of enzyme to survive the temperature of drying breadfruit slices during the processing of the fruit to flour may be proof that alpha amylase activity was mainly responsible for the hydrolysis of starch during the storage of breadfruit flour. Alpha amylase generally is more thermostable than beta amylase (Muralikrishna and Nirmala, 2005).Alpha amylase of *Borassus indica* fruit has been reported to be active at a temperature of 80^{o}C with about 60% retention in activity (Rao *et. al.*, 2005).The specific activity of crude breadfruit alpha amylase obtained in this study was comparable to the range (2.78 – 4.04 units/mL/mg) reported for sorghum maltin a previous study by Coulibaly *et. al.*(2014). This similar

activity with alpha amylase of sorghum malt, in which amylase has been sufficiently synthesized, suggests that breadfruit may be a good source of highly active alpha amylase.The specific activity of crude beta amylase was 2.57 units/mL/mg. Increase in the sugar content of breadfruit flour during storage is indicative of beta amylase activity. The specific activity of crude beta amylase in this study was higher than 1.47 units/mL/mg reported for *Bacillus subtilis* beta amylase isolated from kolanut by Femi-Ola and Ibikunle (2013).

After ammonium sulphate fractionation, the specific activity of alpha amylase increased to 7.65units/mL/mg. This represents a 2.22 fold concentration of enzyme. Ammonium sulphate has been used successfully for partial purification (salting out) of enzyme (protein) because of its high solubility which allows achievement of solution with higher ionic strength (El Nour *et. al.,* 2013; Kanwal *et. al.,*2004). This concentration was higher than 1.46 increase reported for alpha amylase isolated from millet malt after ammonium sulphate treatment (El Nour *et. al.,* 2013). Similarly, the specific activity of beta amylase increased from 2.57 to 5.13 units/mL/mg when the enzyme was precipitated with ammonium sulphate resulting in 2.00 fold concentration that was lower than that of alpha amylase. The protein value of crude alpha amylase was reduced from 2.21 mg/mL to 1.29 mg/mL after ammonium sulphate fractionation while that of beta amylase reduced from 2.30 mg/mL to 1.57 mg/mL.

Conclusion and Recommendations

The assessment of crude amylase activity of breadfruit showed that the enzyme was thermally stable, which may have been responsible for the continuous activity of the enzyme resulting in degradation of breadfruit flour quality during storage. Alpha amylase activity was prominent in the hydrolysis of breadfruit starch compared to beta amylase activity. The study also revealed that breadfruit may be a rich source of alpha amylase.Microwave radiation, EDTA and low pH reduced the activity of breadfruit amylase. Treatment of breadfruit slices with microwave radiation, EDTA and low pH during processing of breadfruit into flour couldtherefore be used to reduce the activity of breadfruit amylase and stabilize breadfruit flour quality during storage.

Table 1. Enzymeactivity and protein content of alpha and beta amylases of breadfruit

Amylases	Step of Purification	Protein (mg/mL)	Enzyme Activity (Units/mL)	Specific Activity (Units/mL/mg)	Purification Fold
Alpha amylase	Crude Enzyme	2.21	7.63	3.45	1.00
	Ammonium Sulphate Fractionation	1.29	9.87	7.65	2.22
Beta amylase	Crude Enzyme	2.30	5.92	2.57	1.00
	Ammonium Sulphate Fractionation	1.57	8.07	5.14	2.00

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STATISTICAL ANALYSIS OF THE FERTERLIZERS'EFFECT ON CROPS

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ABSTRACT

Research was done on twelve (12) independent samples on yields of crops using three fertilizers A, B and C.The statistical tool used is ANOVA F-test for two factors experiment. Statistical Package for the social sciences (SPSS) was used to analyze the data accordingly. The result of the analysis shows that at 5% significant level there was no block effect, that is, on crops (since P-value >α) and therefore accepts the null hypothesis on crops, but there was treatment effect at 5% significant level (P-value <α), and then concluded by rejecting the null hypothesis on fertilizers. Further analysis using multiple comparisons of means on fertilizers (Post Hoc test) by Fisher's Least Significant Different revealed that Fertilizer B (NPK 15-15-1-5) has the highest mean yield, leading to the significant difference among the treatment mean of the groups examined.

Keywords: Ferterlizer, homogeneity, ANOVA, Normality, **B**lock

INTRODUCTION

In completely randomized design (CRD), there is no restriction on the allocation of the treatments to experimental units/plots. But in practical life there are situations where there is relatively large variability in the experimental material. It is possible to make block (in simpler sense groups) of the relatively homogeneous experimental materials or treatments. The design applied in such situations is named as randomized complete block design (RCBD).

The randomized complete block design may be defined as the design in which the experimental materials/treatments is divided into block/group of homogeneous experimental units (experimental units have same characteristics) and each block/group contains a complete set of treatments which are assigned at random to the experimental units/plots.

Actually RCBD is a one restriction design, used to control a variable which influence the response variable. An example of blocking factors might be the gender of a patient (by blocking on gender), this is source of variability controlled for leading to greater accuracy. RCBD is a mixed model in which a factor is fixed and other is random. The main assumption of the design is that there is no contact between the treatment and block effect.

Randomized complete block design is said to be complete design because in this design, the experimental units/plots and numbers of treatment are equal. Each treatment occurs in each block.

On-farm, field scale agronomic research is not a new phenomenon. For example in the 1940's and 1950's, most open pollinated corn varieties were placed by high yielding hybrids across North America. During this time, obvious yields differences among the hybrids become less and apparent, requiring more precise comparisons. The field strip test was institutionalized to fill this on-farm research need. However, debate then increased among scientist as to the relative merits of conducting such

research, compared with highly controlled small plot research replicated and randomized over relatively few locations with field variability tightly controlled (Duvick, 1991)

Over the past 15 years, on-farm research has received few prominences in agricultural systems research which attempts to reduce environmental damage and to increasingly serve the need of society, including the farmer (Anderson and Lockeretz, 1991). Collaboration between university researchers, farmer and producer organizations has increased through program such as the United States Department of Agriculture's Low-input / sustainable Agriculture program where such collaboration is requisite to funding approval. This agency has channeled unprecedented federal funds to groups doing on-farm research (Anderson and Lockeretz, 1992).

Many would agree that research at a system level (whether cropping system or ecosystem) involves a wide number of variables with dynamic relationships. Many would also agree, along with the majority of farmers, that research receives an added and a needed degree of relevance when seen to be applicable at a field and a farm scale. However, the connection between where research takes place and what it can achieve is not always clear. To ensure an effective use of research resources, it is important that the most appropriate study design be used to achieve stated objectives. Similarly, the options for statistical analysis may not be well understood or accommodated in the study design.

The review of the on-farm research methodology literature allows researchers to gain a collective insight to the approach tried by others, and should help to streamline on-farm research techniques and efforts to move standardized protocol.

Design Experimental Layout

Suppose there are t treatments and 'r' blocks in a randomized complete block design, the each block contain homogeneous plots/units are of each treatment. An experimental layout of such a design using four treatments in three blocks is as follows.

Block1	Block2	Block3
A	B	C
B	C	D
C	D	A
D	A	B

From RCBD layout, we can see that:

i. The treatments are assigned at random within block of adjacent subject and each the treatments appears are in block
ii. The numbers of blocks represents the number of replication
iii. Any treatments can be adjacent to any other treatments, but not to the same treatments within the block

The factors under consideration for treatment are; Urea, NPK 15-15-15, and poultry manure (dung) and for block are; Maize, Rice, Cassava, and Barley, using F-test (ANOVA) i.e. two factor experiment.

Research Methodology

The research methodology may be considered as a systematic and scientific process of gathering, recording and analyzing data about problems and issues relating to human existence on earth. The data being collected in this research was through transcription from record, which is a form of secondary data at the Federal College of Agriculture, Akure on twelve independent samples. The method of data analysis is F-test (ANOVA) for two factors experiment.

Assumptions of Randomized Complete Block Design

To every statistical technique or that which we use to analyze statistical data, there must be assumption(s) supporting it or distribution test free (for non parametric test). The following are assumptions of Randomized Complete Block Design (RCBD) with explanation:

1. Sampling:

a. The block are independently sampled

b. The treatment are randomly assigned to the experimental unit/plot within a block

2. Homogeneous variance: the treatment all have the same variability i.e. they all have the same variance

3. Approximate normality: each population is normally distributed.

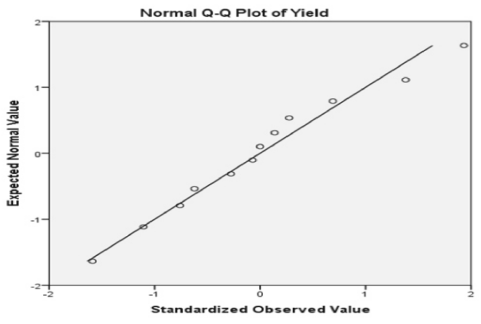
Below are the evidences for test of Normality and Homogeneity of variance of data so collected by means of KS, SW and the common histogram for normality test, as well as Levenes test for homogeneity of variance.

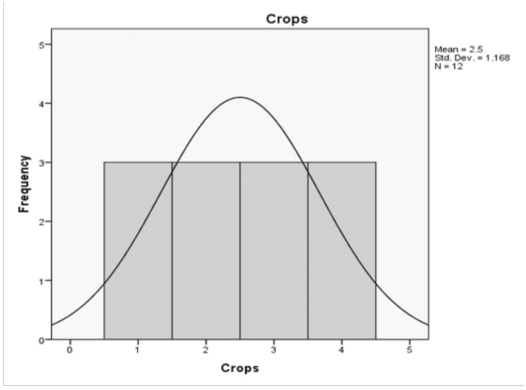
Crops		*Kolmogorov-Smirnov*[a]			*Shapiro-Wilk*		
		Statistic	Df	Sig.	Statistic	Df	Sig.
Yield	maize	.257	3	.	.961	3	.620
	Rice	.276	3	.	.942	3	.537
	cassava	.227	3	.	.983	3	.747
	barley	.328	3	.	.871	3	.298

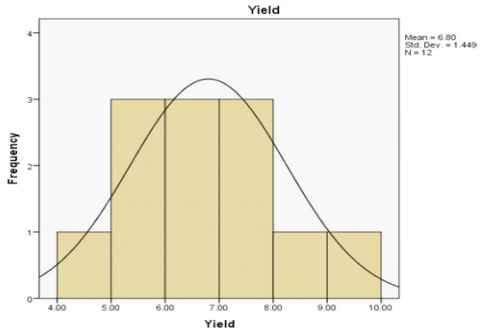
Test of Normality. Table 1

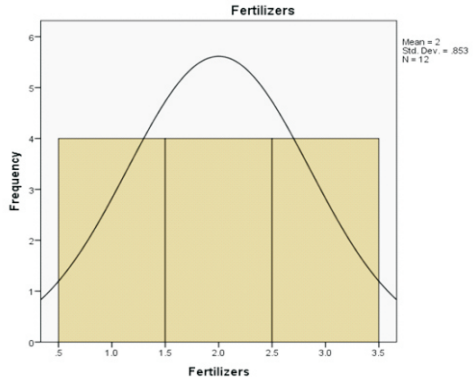
Test of Homogeneity of Variance . Table 2

		Levene Statistic	df1	df2	Sig.
Yield	Based on Mean	.890	2	9	.444









Model of Randomized Complete Block Design (RCBD)

The model of a Randomized Complete Block Design (RCBD) is as below:

$$Y_{ij} = \mu + \tau_i + \beta_j + e_{ij},$$

Where: τ_i is the effect of treatment 'I'. Y_{ij} is the observation in block 'j' receiving treatment 'i' μ is the overall mean/grand mean. β_j is the effect of block 'j'. e_{ij} is the random error which is assumed to be independently and normally distributed with mean zero and constant variance i.e. $e_{ij} \sim N(0, \sigma^2)$

Estimations of Parameters

The parameters here is this research i.e. in randomized complete block design are β_j, μ, τ_i and e_{ij}. In doing this, we use the model, that is,

$$Y_{ij} = \mu + \tau_i + \beta_j + e_{ij}, \text{ so,}$$
$$e_{ij} = Y_{ij} - \mu - \tau_i - \beta_j,$$

Substituting in estimates produces the residual

$$\hat{e}_{ij} = e_{ij} = Y_{ij} - \hat{\mu} - \hat{\tau}_i - \hat{\beta}_j$$

Goal: find $\hat{\mu}$, $\hat{\tau}_i$, and $\hat{\beta}_j$ that maximize L.

$$\mathbf{L = \sum_{i=1}^{a} \sum_{j=1}^{b} \hat{e}_{ij}^2 = \sum_{i=1}^{a} \sum_{j=1}^{b} (yij - \hat{\mu} - \hat{\tau}i - \hat{\beta}j)^2.}$$

Solution: solve the normal equation

$$\mathbf{\frac{\partial L}{\partial \hat{\mu}} = -2\sum_{i=1}^{a} \sum_{j=1}^{b} (yij - \hat{\mu} - \hat{\tau}i - \hat{\beta}j) = 0}$$

$$\mathbf{\frac{\partial L}{\partial \hat{\tau}i} = -2\sum_{j-1}^{b} (yij - \hat{\mu} - \hat{\tau}i - \hat{\beta}j) = 0, \quad for\ i = 1, 2..., a}$$

$$\mathbf{\frac{\partial L}{\partial \hat{\beta}j} = -2\sum_{i=1}^{a} (yij - \hat{\mu} - \hat{\tau}i - \hat{\beta}j) = 0,} \quad \text{for j = 1, 2..., b}$$

After distributing the sum and then simplifying, we get:

i. $\mathbf{Y.. = ab\hat{\mu} + b\sum_{i=1}^{a} \hat{\tau}i + a \sum_{j=1}^{b} \hat{\beta}j}$

ii. $\mathbf{Y_{i.} = b\hat{\mu} + b\hat{\tau}i + \sum_{j-1}^{b} \hat{\beta}j}$ **for i = 1, 2..., a**

$\mathbf{Y_{.j} = a\hat{\mu} + \sum_{i-1}^{a} \hat{\tau}i + a\hat{\beta}j}$ for j = 1, 2..., b

$$\mathbf{\sum_{i=1}^{a} \hat{\tau}i = 0 \text{ and } \sum_{j=1}^{b} \hat{\beta}j = 0.}$$

Substituting of these constraint into (i),(ii), and (iii) yields.

(1) $ab\hat{\mu} = Y..$ (2) $b\hat{\mu} + b\hat{\tau}_i = Y_{i.}$ (3) $a\hat{\mu} + a\hat{\beta}_j = Y_{.j}$

Then, from (i), we have

$$\hat{\mu} = \frac{y..}{ab} = ? \ ..$$

Substitution of $\hat{\mu} = \bar{Y}..$ in (2) yields:

$$b\bar{Y}.. + b\,\hat{\tau}_i = y_{i.} \rightarrow ? \quad .. + \hat{\tau}_i = \bar{Y}_{i.} \rightarrow \hat{\tau}_i = \bar{Y}_i - \bar{Y}..$$

Substitution of $\hat{\mu} = \bar{Y}..$ in (3) yields:

$$a\bar{Y}.. + a\hat{\beta}_j = y_{.j} \rightarrow ? \quad .. + \hat{\beta}_j = \bar{Y}_{.j} \rightarrow \hat{\beta}_j = \bar{Y}_{.j} - \bar{Y}..$$

Partitioning of Sum of Squares

In statistics, the sum of squares is a measure of the total variability (spread, variation) within a data set. In other words, the sum of squares is a measure of deviation or variation from mean value of the given data set.

$\Sigma(Y_{ij}- \bar{Y}..)^2 = \Sigma[(\bar{Y}_{i.}- \bar{Y}..)^2 + (\bar{Y}_{.j}- \bar{Y}..)^2 + (Y_{ij}- \bar{Y}_{i.}- \bar{Y}_{.j} + \bar{Y}..)^2]$

$= b\Sigma(\bar{Y}_{i,}- \bar{Y}..)^2 + t\Sigma(\bar{Y}_{.j}- \bar{Y}..)^2 + \Sigma(Y_{ij}- \bar{Y}_{i.}- \bar{Y}_{.j}+ \bar{Y}..)^2$ + cross product, which is assumed to be zero.

Where:

$\Sigma(Y_{ij}- \bar{Y}..)^2$ is the total variation/ sum of squares of total

$b\Sigma(\bar{Y}_{i,}- \bar{Y}..)^2$ is the sum of squares of treatment

$t\Sigma(\bar{Y}_{.j}- \bar{Y}..)^2$ is the sum of squares of block; and

$\Sigma(Y_{ij}- \bar{Y}_{i.}- \bar{Y}_{.j}+ \bar{Y}..)^2$ is the sum of squares of error

The above sum of squares can be written as:

$SST = \Sigma Y_{ij}^{\ 2} - (Y..^2/bt)$

$SSb = (\Sigma Y_{.j}^{\ 2}/t) - (Y..^2/bt)$

$SSt = (\Sigma Y_{i.}^{\ 2}/b) - (Y..^2/bt)$

$SSE = SST - SSt - SSb$

b is the number of blocks

t is the number of treatments

bt is the total number of observations

$Y_{i.}$ Is the treatment total/ row total

$Y_{.j}$ is the block total/ column total; and

Y.. is the overall/grand total

Theoretical Analysis Of Variance

The theoretical analysis of variance for two factors experiment is as below:

ANOVA TABLE FOR RCBD TABLE 3

Sources of variation	Degree of freedom	Sum of squares	Mean squares	F-ratio	F-tab
Treatment	t-1	SSt	SSt/(t-1)	Mst/Mse=F_1	$F_\alpha(v_1,v_2)$
Block	b-1	SSb	SSb/(b-1)	Msb/Mse=F_2	$F_\alpha(v_1,v_2)$
Error	(t-1)(b-1)	SSE	SSE/(t-1)(b-1)		
Total	bt-1	SST			

STATISTICAL PRESENTATION AND COMPUTATION :

The data presented is a table presentation.

DATA PRESENTATION : TABLE 4

	Maize	Rice	Cassava	Barley
Urea	4.5	6.4	7.2	6.7
NPK 15-15-15	8.8	7.8	9.6	7.0
Poultry manure	5.9	6.8	5.7	5.2

COMPUTATIONS OF DATA TABLE 5

	Maize	Rice	Cassava	Barley	$Y_{i.}$	$\bar{Y}_{i.}$
Urea	4.5	6.4	7.2	6.7	24.8	6.2
NPK 15-15-15	8.8	7.8	9.6	7.0	33.2	8.3
Poultry manure	5.9	6.8	5.7	5.2	23.6	5.9
$Y_{.j}$	19.2	21.0	22.5	18.9	Y.. =	81.6
$\bar{Y}_{.j}$	6.4	7.0	7.5	6.3	$\bar{Y}$.. =	6.8

Where: $Y_{i.}$ is the row/trt total

$Y_{.j}$ is the column/block total

$\bar{Y}_{i.}$ is the row/trt mean

$\bar{Y}_{.j}$ is the column/block mean

$\bar{Y}$.. is the overall/grand mean

Y.. is the overall/grand total.

The correction factor (CF), $Y..^2/bt = 81.6/4(3) = 6,658.56/12 = 554.88$

Therefore, CF = 554.88

$SST = \Sigma Y_{ij}^{\ 2} - (Y..^2/bt) = (4.5)^2+(6.4)^2+(7.2)^2+(6.7)^2+(8.8)^2+(7.8)^2+(9.6)^2+(7)^2+(5.9)^2+(6.8)^2+(5.7)^2+(5.2)^2 - 554.88 = 577.96 - 554.88 = 23.08$

Therefore SST = 23.08

$SSt = (\Sigma Y_{i.}^{\ 2}/b) - (Y..^2/bt) = [(24.8)^2 + (33.2)^2 + (23.6)^2]/4 - 554.88 = 2,274.24/4 - 554.88 = 568.56 - 554.88 = 13.68$

Therefore SSt = 13.68

$SSb = (\Sigma Y_{.j}^{\ 2}/t) - (Y..^2/bt) = [(19.2)^2 + (21)^2 + (22.5)^2 + (18.9)^2]/3 - 554.88 = 1,673.10/3 - 554.88 = 557.7 - 554.88 = 2.82$

Therefore SSb = 2.82

$SSE = SST - SSt - SSb = 23.08 - 13.68 - 2.82 = 6.58$

Therefore SSE = 6.58

$Mst = SSt/(t-1) = 13.68/2 = 6.84$
$Msb = SSb/(b-1) = 2.82/3 = 0.94$
$Mse = SSE/(t-1)(b-1) = 6.58/6 = 1.0966$
$F_1 = Mst/Mse = 6.84/1.0966 = 6.2374$
$F_2 = Msb/Mse = 0.94/1.0966 = 0.8571$

ANALYSIS OF VARIANCE FOR YIELD TABLE 6

Source of variation	Degree of freedom	Sum of squares	Mean square	F- ratio	F –tab
Fertiliser	2	13.68	6.84	$6.2374 = F_1$	$F_{0.05}(2,6) = 4.76$
Crop	3	2.82	0.94	$0.8571 = F_2$	$F_{0.05}(3,6) = 5.14$
Error	6	6.58	1.0966		
Total	11	23.08			

Hypothesis Testing

Step1: STATEMENT OF HYPOTHESIS

For treatment (fertilizer)

H_o: $\tau_i = 0 \forall_i$ Vs H_i: $\tau_i \neq 0$ for at least one 'i'

For block (crop)

H_o: $\beta_j = 0 \forall_j$ Vs H_i: $\beta_j \neq 0$ for at least one 'j'

Step2: TEST STATISTICS

F- test (ANOVA for RCBD) is the test statistics used.

Step3: LEVEL OF SIGNIFICANT

The level of significant, denoted by α is at 5% or 0.05

Step4: reject H_o if $F_{cal} \geq F_{tab}$

Step5: For crop, since $F_{cal} < F_{tab}$ i.e. $0.8571 < 4.76$, we do not reject the null hypothesis at 5% level of significance, and conclude that there is no significant difference in yields due to crops. i.e. $\beta_j = 0 \forall_j$.

For fertilizer, since $F_{cal} > F_{tab}$ i.e. $6.2374 > 5.14$, we do not accept the null hypothesis at 5% level of significance, and conclude that there is significant difference in yields due to fertilizers i.e. $\tau_i \neq 0$ for at least one 'i'.

The confidence interval for the three fertilizers indicates that it is likely that Fertilizer B produces higher mean yields than either Fertilizer A or C.

Interpretations

From the analysis of the experiment in the previous chapter, it shows that there is a significant difference in the use of Urea, NPK 15-15-15, and Poultry manure (dung) and that these have a great impact in the yields of crops. The field study shows that application of the 'factors' Urea, NPK 15-15-15 and Poultry manure significantly increase in the yields of crops (Maize, Rice, Cassava, and Barley).

Conclusions

Based on the result of the statistical analysis carried out in previous chapter, at 5% level of significance of which $F_{cal} > F_{tab}$ i.e. $6.2374 > 5.14$ for the factors level revealing that there is at least one significant difference on the effect of Urea, NPK 15-15-15, and Poultry manure on the yields of crops (four different crops).

After this test, some reasonable facts can be deducted.

The null hypothesis for Urea, NPK 15-15-15, and Poultry manure was rejected at 5% level of significance. This can simply be interpreted that the effect of these factors (treatment) are significantly different from each other in the application of different factor- Urea, NPK 15-15-15; poultry manure in the yields of crops (Maize, Rice, Cassava, and Barley).

By calculating the averages or means of each treatment, it is discovered that the treatment B, which is NPK 15-15-15 has the highest or greatest possible yields, causing the null hypothesis to be rejected, which was revealed by Post Hoc tests (LSD) using SPSS based on the research.

Similarly, the null hypothesis of the block (crops) was accepted at 5% level of significance i.e. $F_{cal} < F_{tab}$ $(0.8571 < 4.76)$, within the block at this level indicates that; there is no significant different within the blocks based on the research.

Recommendations

As evidence from the results and facts in any research, focus should be based on plant crops, that is, plant grown to be

harvested as food. Plant crops, as we all know that they are inevitable in human lives for various purposes across the globe especially Nigeria. Therefore, intensive care should be taken in carrying out experiment on them.

Based on the research, it is thereby recommended that NPK 15-15-15 which has the highest/greatest possible mean yield value should be encouraged and made available for farmers at all levels.

Our farmers should be oriented, exposed and thought on the use and application of NPK 15-15-15, urea, poultry manure e. t. c. to their respective farm crop.

There should be adequate mobilization on the maintenance and management of some soil chemicals should be made known to the farmers.

Finally, government should come to the aid of the farmers through financial assistance; subsidize agriculture inputs to flaunt their product/output.

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CRYSTALLIZATION OF SODIUM ALUMINOSILICATE GLASS DEVELOPED FROM AGRO-WASTE BY THE PETRURGIC METHOD

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Abstract

The controlled crystallization of certain glasses results in the formation of a special material known as glass ceramics. This material has several advantages over its parent glass. The objective of this research is to crystallize sodium aluminosilicate glass to produce glass ceramic. A sodium aluminosilicate glass batch was formulated using agricultural waste; corn cob ash (CCA) and adding alumina and soda ash as supplementary sources of sodium oxide and alumina. The Petrurgic method was employed for this study. The batch was melted in ceramic moulds at 1200°C and cooled to room temperature at the rates of 1°C, 5°C and 10°C per minute in a temperature-controlled furnace. The samples obtained were characterized by X-ray diffraction and Scanning electron microscope to determine their phase constituents andmicrostructural characteristics respectively. The results showed the presence of both crystalline and amorphous phases which identified the material obtained from test-melting the batch as glass ceramics.The glass ceramic samples developed are suitable for commercial applications like, floor tiles and wall claddings, building bricks, table ware, etc.

Keywords: Crystallization; Sodium aluminosilicate glass;Glass ceramics;Agro-waste; Petrurgic method.

INTRODUCTION

The crystallization or devitrification, of glass to form a glass ceramic in most cases is a heterogeneous transformation and as such consists of two stages, namely a nucleation stage and a growth stage. In the nucleation stage small, stable volumes of the product (crystalline) phase are formed, usually at preferred sites in the parent glass. In the conversion of glass to glass ceramics from nuclei formation to crystal growth,the preferred sites are interfaces within the parent glass or the free surface (Holand and Beall, 2002). The latter is usually undesirable as the resulting glass ceramic microstructure often consists of large oriented crystals that are detrimental to mechanical properties. However, in a few instances an oriented structure is beneficial e.g., glass ceramics for piezoelectric and pyroelectric devices and machinable glass ceramics.

Once a stable nucleus has been formed the crystal growth stage commences. Growth involves the movement of atoms/molecules from the glass, across the glass-crystal interface, and into the crystal. The driving force for this process is the difference in volume or chemical free energy between the glass and crystalline states. The transport of atom/molecules across the interface is thermally activated with associated activation energy (Holand and Beall, 2002). Glass ceramics from waste can be produced by a method, known as the "petrurgic method" Rincón and

Romero (1999), named it this way because of the similarity with the process of crystallization of natural rocks (Rincón *et.al*., 1999). This method has actually been applied since the 1970s, with the development of "Silceram" ceramics from metallurgical slags (Ponsot, 2015). It was found with "Silceram" that it made little difference whether the glass was heated up to Nucleation and Maximum Crystallization Temperature (T_{NG})from room temperature or the molten glass was cooled to T_{NG}.This led to the development of the production of certain glass ceramics by a controlled, usually very slow cooling of the parent glass from the molten state without a hold at an intermediate temperature. With this method, both nucleation and crystal growth can take place during the cooling. (Francis *et. al.*, 2002)

In recent years glass ceramics has been produced by synthesis of materials from ash gotten from agricultural waste such as rice husk, corn cob etc., combination of metal and non-metals had been investigated by sol-gel to produce ceramics (Samuel, 2015).Numerous silicate based wastes, such as slag from steel production,(Saad and Hussein, 2006)fly ash, (Rincón *et.al*., 1999) and different types of sludge as well as glass cullet (Ponsot, 2015) have been considered for the production of glass-ceramics. Magnetic glass-ceramics have been obtained from mixtures of coal ash and 20-60wt% soda-lime glass by the petrurgic method **(**Francis *et al*., 2002).

2. Materials and Methods

2.1. Materials

The raw materials used in the course of this work for preparation of sodium aluminosilicate glass ceramics are corn cobs (agro waste), alumina and soda ash. The corn cobs were obtained from agro processing plant while as-received alumina and soda ash are highly pure analytical grade and are used as supplementary sources of alumina and sodium oxide. The as-received corn cobs were initially beneficiated by washing to remove adherence of dirt and unwanted particles and air-dried for 7 days. The corn cobs were then ground to smaller particles sizes of about 10mm to enhance adequate combustion and reduce carbon content (**Adesanya and Raheem, 2009).** The ground corn cobs were placed in an incinerator for combustion into ash. The ash obtained was poured inside crucibles and placed in a muffle furnace and heated at a temperature of 600°C for 6 hours to reduce the carbonaceous matter and increase the percentage of active silica content. The obtained whitish corn cob ash was then sieved through a 0.25mm sieve with mesh number 60.The determination of the chemical composition of the corn cob ash was carried out by X-ray fluorescence spectrometry which identified each of the oxides contained in the ash.

2.2. Batch formulation

The standard composition of sodium aluminosilicate glass was utilized for the batch formulation of the base glass which was converted to glass ceramics. The corn cob ash was used as the major glass former (silica precursor) while alumina and soda ash was used to provide other supplementary oxides required in the batch. The approximation method was used in calculating the batch based on the percentage yield of the major oxides introduced by the various raw materials. A total of 127.56% of batch raw materials was needed for 100% of glass.

2.3. Glass ceramics production by Petrurgic method

The Petrurgic method was employed for the development of glass ceramics. The formulated batch was melted in ceramic

moulds at 1200°C for 5 hours and cooled to room temperature at the rates of 1°C, 5°C and 10°C per minute to produce a total of 24 samples A, B and C (8 samples each)in a temperature controlled electric muffle furnace. The glass ceramics production was carried out at Dana Steel Limited, Nigeria. Tale 1 shows the heating schedules utilized to obtain the glass ceramics.

2.4. Characterization

According to ASTM E-986, scanning electron microscopy (SEM) which involves the microstructural morphology of selected spots on each glass ceramic sample was analysed. X-ray diffraction (XRD) according to ASTM E-975 was carried out on glass ceramic sample where the sample was finely ground and homogenized and mounted on a goniometer and gradually rotated while being bombarded with X-rays, producing a diffraction pattern of regularly spaced spots known as reflections which determined its atomic and molecular structure.

3. Results and Discussion

3.1. Chemical composition (corn cob ash)

The result of XRF analysis of the corn cob ash (CCA) as shown in Table 2 reveals that it contains 68.70% SiO_2 and the rest 29.416%, making the corn cob ash a good source of SiO_2 for glass and glass ceramic production. Also, the Fe_2O_3 content of 3.44% is high enough to serve as a nucleating agent for glass ceramic production.

3.2. Visual observation

Figures 1a, 1b and 1c showed the resultant glass ceramics cooled at varying temperature ranges from molten state. They were characterized by a rough surface which is as a result of inhomogeneity of the melt which is due to the fact that the alumina contained in the batch requires a higher temperature of 1500°C to melt. Therefore complete melting of alumina failed to occur at 1200°C. The batch melted at 1200°C due to the particle size of the batch which was 0.25mm. Also the sodium oxide (Na_2O) contained in the corn cob ash and the addition of soda ash to supplement for the required amount of Na_2O required for the development of sodium aluminosilicate glass facilitated the melting process by bringing down the melting point of the batch.

3.3. Microstructure and phase characterization

Figures 2 (a) and (b) showed the representative morphology of glass ceramics obtained from cooling at 1°C/min and 5°C/min respectively. The morphology of the glass ceramic sample obtained from cooling at 1°C/min showed an irregularly-shaped structure which was due to the precipitation of ceramics in the glassy matrix. So, the grains and clusters shown by this surface are attributed to the formation of nepheline phases. The morphology of the crystalline phase from glass ceramics obtained from cooling at 5°C/min was characterized by a rough texture also with irregular shapes on it.

Figures 3 (a) and (b) showed the phase composition by XRD patterns of glass ceramic samples obtained from cooling at 1°C/min and 5°C/min respectively. Both indicated sharp Bragg's peak zones near 2

Table 1: Heating schedules at Dana Steel Limited, Nigeria.

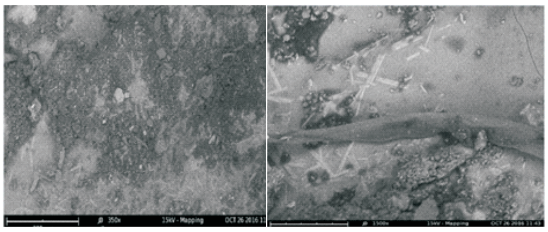
Samples	Cooling rate	Duration
A	1°C/minute	5 h (melting) & 20 h (cooling)
B	5°C/minute	5 h (melting) & 4h (cooling)
C	10°C/minute	5 h (melting) & 2 h (cooling)

Table 2: Result of XRF of CCA

Oxides	SiO_2	P_2O_5	K_2O	CaO	Na_2O	MgO	TiO_2	MnO	Fe_2O_3	others
Composition (%)	68.70	1.61	4.56	9.50	4.60	5.20	0.26	0.14	3.44	0.11

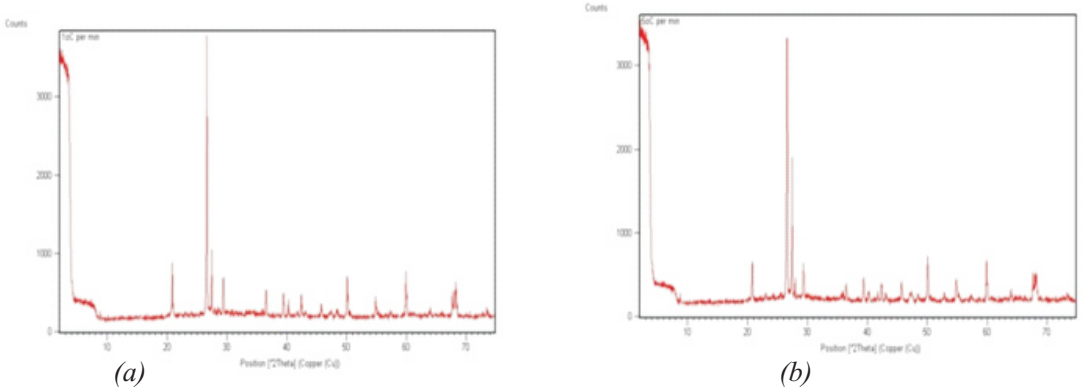
(a) (b) (c)

Figure 1: Glass ceramics obtained from cooling at (a) 1°C/min (b) 5°C/min (c) 10°C/min



(a) (b)

Figure 2: SEM images of glass ceramics obtained from cooling at (a) 1°



(a) (b)

Figure 3: XRD Pattern of glass ceramics cooled at (a) 1°C/min (b) 5°C/min

WATER QUALITY PARAMETERS AND FISH DIVERSITY OF UREJE DAM, ADO EKITI

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ABSTRACT

Study on the physico-chemical parameters and fish diversity of Ureje Dam, Ekiti State, Nigeria was conducted from October to November 2019. La Motte Fresh Water Aquaculture Test Kit (Model: AQ-2, Code: 3633- 03) was used in determining the values of dissolved oxygen (DO), pH, alkalinity, Temperature, Electrical conductivity, while phosphate and Nitrate was determined at Microbiology Laboratory, Afe Babalola University, Ado Ekiti (ABUAD). The study shows that mean values of the physico-chemical parameters obtained were within the acceptable ranges for safe aquatic lives. The mean values for water temperature, pH, alkalinity, conductivity, and dissolved oxygen shows significant variation in the two sampling stations in Ureje Dam. The mean value of pH, Temperature, Alkalinity and Nitrate in shallow area were significantly higher ($P \leq 0.05$) than those of deep area while the mean value of conductivity and phosphate were higher in deep area than shallow area. Fish species composition and distribution were determined using a fleet of seven multifilament gill nets in sampling the shallow and deep area of the sampling stations and artisanal catch assessment surveys was adopted. Four families of fish (Cichlidae, Clariidae, Hepsetidae and Cyprinidae) represented by seven species of fish were recorded in both experimental gill net sampling and commercial catches of fishermen in the Ureje Dam. The family Cichlidae formed the dominant family both in number and weight in the dam and also dominated the two major habitats (shallow and deep area) of the dam. Oreochromis niloticus was the most abundant fish species recorded in the experimental gill net sampling of Ureje Dam.

INTRODUCTION

There are about 268 different freshwater fish species in Nigeria. They inhabit over 34 wellknown fresh water bodies (rivers, lakes and reservoirs) which constitute about 12% of Nigerians total surface area put about 94,185,000 ha (Ita 1993). Fish stocks in rivers are generally replenished from their adjacent flood plains after each flood season during which fish breed. Therefore, any natural phenomenon as drought or artificial activities such as dam construction, which eventually affect the natural cycle of flooding, will certainly undermine fish species diversity both in lakes and wetlands. Considering this facts, therefore, that lakes, wetlands and reservoirs are supplied with by their inflowing rivers, the rivers will be characterized by higher species diversity (Ita, 1993).

Water is the most vital resources of all kinds of life on earth and essential for the sustainability of the earth's ecosystem (UNESCO, 2003). Fresh water is essential to human health, agriculture, natural ecosystem and industry. Fresh water bodies are also used for stocking fish, domestic use, drinking and also for irrigation. Rapid growth of population, increasing living standard in urban areas and industrialization have resulted in

greater demands of quality water (Miller *et. al.,* 2002).

Important physical and chemical parameters influencing the aquatic environment are temperature, pH, salinity, dissolved oxygen and carbon dioxide. Others are total suspended and dissolved solids, total alkalinity and acidity and heavy metal contaminants. These parameters are the limiting factors for the survival of aquatic organisms (flora and fauna). Poor water qualities may be caused by low water flow, municipal effluents and industrial discharges (Chitmanat and Traichaiyaporn 2010).

Dissolved oxygen (DO) affects the solubility and availability of nutrients. Its low levels can results in damages to oxidation state of substances from the oxidized to reduced form thereby increasing the levels of toxic metabolites (Oniye *et al.,* 2002). Bala and Bolorunduro (2011) reported a range of 4.7- 9.8mg/l in Sabke Reservoir with no significant variations in seasonal concentration. Alkalinity of a water body is a measure of its capacity to neutralize acids to a designated pH (Edokpayi, 2005). According to Boyd (1982) permit plankton production for fish culture. High alkalinity results in physiological stress on aquatic organisms and may lead to loss of biodiversity. Andem *et al*. (2012) reported that the alkalinity of Ona River range between 67.76- 82.64mg/l, while Anago *et al*. (2013) reported a range of 0.8- 1.7mg/l alkalinity in Awba Reservoir.

Ramanathan *et al.* (2005) recommended optimum range of pH 6.8-8.7 for maximum growth and reproduction of carp. pH is influenced by the acidity of the bottom sediments and biological activities. High pH may result from high photosynthesis by dense phytoplankton blooms. pH higher than 8.5 according to Abowei (2010) is ideal for biological productivity, but pH value of 7.14- 8.875 with no significant difference in seasonal variations. Offem *et al*. (2011) reported a mean pH value of 5.8 in Ikwori, South-Eastern Nigeria and there was no significant difference in seasonal variations. Andem *et al.* (2012) reported a pH range of 7.27- 7.47 in Ona River while a pH range of 7.3- 8.4 has also been reported in Awba Reservoir, Ibadan (Anago *et al*., 2013)

Mustapha (2008) reported a range of 80.4-178.8µS/cm EC in Oyun Reservoir, 53.33-130.00µS/cm EC was reported by Bala and Bolorunduru (2011) in Sabke Reservoir with no significant difference in seasonal variation. Andem *et al.* (2012) reported a range of 270.35- 295.56µS/cm EC in Ona River while a range of 290.8- 391.5µS/cm was reported by Anago *et al.* (2013) inAwba Reservoir with highest value recorded in May and lowest in July.

Lawson and Olusanya, 2010 reported that Species richness is the fundamental unit in which to assess the homogeneity of an environment and commonly used in conservation studies to determine the sensitivity of ecosystems and their resident species, while the relative abundance describes how common or rare a species is relative to other species in a given community and are usually describe for a single trophic level.

Offem *et al.* (2011) reported seasonal differentiation in the richness and diversity indices of Plankton and fish species of Ikwori Lake with higher values for dry season samples than wet season. Yakub (2012) reported higher fish total abundance (1061), species number (38) and diversity levelin rainy season than dry season when a total abundance of 358 and 28 species were recorded in Lower Ogun River, Ishasi, and Ogun State.

Ita *et al*. (1985), in a preliminary report on the immediate post impoundment fishery survey of Shiroro Reservoir, recorded that the family Cichlidae dominated the catch. Lates *niloticus* ranked third in terms of abundance in the experimental sample, and forth in commercial landing.

Balogun *et al*. (2000) in the study of Zaria Reservoir recorded 18 species of fish belonging to the nine families. Fourteen of the species are of major economic importance which includes *Oreochromis niloticus,Sarotherodon galilaeus, Alestes macrolepidotus, Schilbe mystus, Lates niloticus* and *Petrocephalus bane*. Others are *Mormyrus rume, Auchenoglanis occidentalis, Mormyrus deliciosus, Marcusenius psittacus, Synodontis membraneceous and Clarias gariepinus*. In terms of number, the family Latidae represented only by *Lates niloticus* dominated, while in terms of weight of fish, family Mormyridae dominated followed by fish family Latidae. In terms of habitat distribution, the family Schilbidae dominated in the shore by number but by weight it was the family Mormyridae, while in the surface and botton habitats, the fish family Latidae dominated by number and weight

MATERIALS AND METHODS

Study Area

Ureje Dam is the headquarters of Water Corporation in Ekiti State, situated at water works Ureje quarters, Ajilosun Street in Ado - Ekiti, Ekiti State. It is one of the major reservoirs inherited by the state from the former Ondo State in 1996. Geographically, Ado Ekiti is at an altitude of 433 meters above sea level and lies within the tropical rainforest zone of southwestern Nigeria between 7° 35' N and longitude 5 ° 12'E. The reservoir was constructed by damming of Ureje River in 1958, and water from the dam is being supplied to the public for domestic purposes in AdoEkiti and neighbouring towns with fish production as an ancillary purpose.

A stretch of grass covers the banks of the reservoir and among these are sparsely distributed trees. Notable herbs along the banks are *Talinum triangulare; Tridax sp,* Guinea grass, Elephant grass, (*Pennisetum purpureum*) giant star grass (*Cynodon plectostachyus*), Rhodes grass *(Chloris gayana*), Siam weed (*Eupatorium odoratum*). Aquatic birds such as ducks visit the reservoir, several species of snails are present such as *Indoplanorbis exustus* and *Biomphalaria species*. Fish fauna found in the reservoir include the following: *Tilapia zilli*, *Clarias gariepinus*, *Oreochromis niloticus, Heterobranchus bidorsalis, Hepsetus odoe* and *Barbus sp.*

Sampling Stations

Two sampling stations were selected for this study. Station A is the shallow area and less deep, and can be referred to as dam dike,fish in this area was captured with hooks and line with less stress. Station B is the main dam, fish was captured with the use of cast net. On each occasion, water and fish samples were collected between 6:00 a.m. and 8:00 a.m

Determination of Physico-chemical Parameters

The Physico-chemical parameters of water were determined using LaMotte Fresh Water Aquaculture Test Kit (Model: AQ-2, Code: 3633-03). Water temperature, pH of water, electrical conductivity,dissolved oxygen (DO), alkalinity, Nitrate and Phosphate were determined.

Temperature

Air temperature was determined by holding the thermometer calibrated in degree centigrade under the shade at bank of the reservoir for about 2-4 minutes

before reading and value recorded, while the water temperature was determined by lowering the thermometer into the water body and retained inside for about 2-4 minutes before reading while in water and value recording thereafter.

Dissolved Oxygen (DO)

Water sampling bottles were rinsed thoroughly with sample water and tightly capped. The bottles were submerged to a desire depth; the cap was removed and filled with sample water. 8 drops of manganous sulfate solution were added, and 8 drops of alkaline potassium iodide azide reagent added, capped and mixed by inverting several times. A precipitate was formed and allowed to settle below the shoulder of the bottle. 8 drops of sulfuric acid acid were added cap and gently shaken until the precipitate dissolved. A clear- yellow to brownorange colour was developed. The titration tube was filled to the 20mL line with the sample water and cap. The Direct Reading Titrator was filled with sodium thiosulfate (0.025N). The titrator was inserted into the centre hole of the tube cap. While gently swirling the tube, the plunger was slowly pressed to titrate until yellow-brown colour was reduced to a very a faint yellow. Titrator and cap were removed and 8 drops of starch indicator solution were added. The solution turn blue, the cap and titrator was replaced and titration continued until the blue colour disappeared. The test result was read directly from the scale where the large ring on the titrator meet titrator barrel and recorded as mg/O_2/L Dissolved Oxygen.

Alkalinity

5ml of sample water was used determined the alkalinity of water and 4drops alkalinity indicator were added, capped and mixed for the solution to turn blue-green. Direct Reading Titrator was filled with alkalinity titration reagent. The titrator was inserted into the centre hole of the test tube cap. While gently swirling the test tube, the plunger was slowly pressed to titrate until blue-green colour changes to pink. The test result was read directly from the scale where the large ring on titrator meet the titrator barrel and recorded as ppm total alkalinity as calcium carbonate (CaCO3).

Determination of pH and Electrical Conductivity

They were determined using La Motte Tracer (pocketester) code 1766. The readings were taken by changing the mode of the tracer and the values recorded for each of these properties. The electrical conductivity was expressed in micro-siemen per second (μs^{-1}) The LaMotte fresh water aquaculture test kit uses two basic analytical procedures common to field test kits; the colorimetric and titrimetric procedures.

Determination of Phosphate

500cm^3 of water sample was pipetted into a 500cm^3 volumetric flask, 5cm^3 of Ammonium molybdate solution and 3.0cm^3 of ascorbic acid were added with swirling, the mixture was diluted to the mark with deionised water and was allowed to stand for 30 minutes for maximum colour development, the absorbance was then read at 660nm including the bank. This procedure was applied for the remaining samples and the standard solutions.

Determination of Nitrate

10$cm^3$of the water sample was pipetted into a 50 cm^3 volumetric flask. 10cm^3 of 13N sulphuric acid was added and mixed with swirling, the flask was allowed to come to a thermal equilibrium in cold water bath (0-10) ^oC. 0.5cm^3 of brocine –sulfanilic acid was added and diluted to the mark with deionised water, the solution was then placed on the 100^oC hot water bath for about 25 minutes for

maximum colour development, the flask was then cooled to room temperature. The absorbance was read at 410nm including the bank. This procedure was repeated on the other samples including the standard solutions for making standard calibration

Survey of Fish Species Composition

The survey of the fishes in Ureje Dam took place at two sampling stations at the shallow and deep areas by employing catch assessment survey. The period of the survey covered 2 months (October to November 2019) and data were collected on the monthly bases.

Catch Assessment Survey

This involved the actual count and weighing of the fishes caught by the local fishermen at the Ureje Dam site for two months as described by Balagun and Auta (2001). The total weight of fish caught by each fisherman was obtained by the use of weighing balance (gm). All fish species were identified using relevant reference texts by Olaosebikan and Raji (1998) and Idodo-Umeh (2003).

Statistical Analyses

Analysis of data was based on two months collection. Data obtained from identification, counting and weighing of fish were used to compute fish abundance and weight abundance for each station. Analyses of variance (ANOVA), T-test and Pearson"s product moment correlation coefficient (r) were used to analyse the data collected using SPSS version 20. In the statistical analysis a 95% confidence level or 5% level of significance ($P \leq 0.05$) was used in interpreting relationship between factors studied.

RESULT

Physico-Chemical Parameters of Ureje Dam

The study shows that there were variations in the mean temperature of the two sampling stations of Ureje Dam as presented in Table 1. The temperature ranged between 28.45 ± 0.08°Cin the Station A (shallow area) to 25.20 ± 0.04 °C in the Station B (Deep area). The temperature variations between the two stations were not significantly different ($P \geq 0.05$).

The mean pH of Ureje Dam ranged between 7.74 ± 0.07 and 7.69 ± 0.09 for Station A and Station B respectively as presented in Table 1. The analyses shows that there was significant different ($P \leq 0.05$) between the sampling stations.

The results of the Dissolved oxygen, Alkalinity and Nitrate for both stations were 7.30 ± 0.04 mg/L and6.70 ± 0.14 mg/L; 34.00 ± 0.20 mg/ $CaCO_3$ and 33.00 ± 0.20 mg/ $CaCO_3$; 24.05 ± 0.45mg/L and 19.90 ± 0.38mg/L respectively as presented in Table 1. The results show that there were no significant different ($P \geq 0.05$) between the sampling stations.

The mean conductivity and phosphate for station A and station B ranged between 774.30 ± 5.90 (µS); 840.75 ± 1.55 (µS) and 75.30 ± 1.10 (mg/L); 77.93 ± 0.37 (mg/L) respectively as presented in Table 1.

TABLE 1: Mean of Physico-chemical parameters of study stations of Ureje Dam

PARAMETERS	STATION A (Shallow Area)	STATION B (Deep Area)
PH	7.74 ± 0.07^a	7.69 ± 0.09^b
Temperature (^OC)	28.45 ± 0.08^a	25.20 ± 0.04^a
Dissolved oxygen ($mg/O_2/L$)	7.30 ± 0.04^a	6.70 ± 0.14^a
Alkalinity ($mg/CaCO_3$)	34.00 ± 0.20^a	33.00 ± 0.20^a
Conductivity (µS)	774.30 ± 5.90^a	840.75 ± 1.55^b
Nitrate (mg/L)	24.05 ± 0.45^a	19.90 ± 0.38^a
Phosphate (mg/L)	75.30 ± 1.10^a	77.93 ± 0.37^b

*Values with different superscripts along the rows were significantly different ($P \leq 0.005$).

* = Indicates significantly calculated P-value.

Percentage Fish abundance (%) during October period

A total of 204 fish individuals weighing 20,148g were recorded in the Ureje Dam during october period as presented in Table 2. The family Cichlidae has the highest number of individuals and weight followed by Clariidae both in number and weight while Cyprinidae recorded least number of individuals and weight. *Oreochromis niloticus*recorded the highest number (35.78%) of individuals and weight (32.66%) followed by *Tilapia zillii* in number (22.55%) and weight (12.84%) and the least abundance was represented in *Labeo senegalenssis* both in number and weight.

TABLE 2: Fish Abundance at Ureje Dam during October period

Families/Species	Fish Abundance	Percentage Abundance (%)	Weight (g)	Percentage Weight (%)
Cichlidae				
Oreochromis niloticus	73	35.78	6580	32.66
Sarotherodon galileaus	42	20.59	2866	14.22
Tilapia zilli	46	22.55	2586	12.84
Clariidae				
Clarias gariepinus	30	14.71	5680	28.19
Hepsetidae				
Hepsetus odoe	10	4.90	2030	10.08
Cyprinidae				
Labeo senegalenssis	03	1.47	406	2.02
Total	**204**	**100**	**20148**	**100**

Percentage Fish abundance (%) during November period

A total of 361 fish individuals weighing 3,2648g were recorded in the Ureje Dam during November period as presented in Table 3. The family Cichlidae has the highest number of individuals and weight followed by Clariidae both in number and weight while Hepsetidae recorded least number of individuals and weight. *Oreochromis niloticus*recorded the highest number (33.52%) of individuals and weight (33.36%) followed by *Sarotherodon melanotheron* in number (29.36%) and weight (13.81%) and the least abundance was represented *Hepsetus odoe*both in number and weight.

TABLE 3: Fish Abundance at Ureje Dam during November period

Families/Species	Fish Abundance	Percentage Abundance (%)	Weight (g)	Percentage Weight (%)
Cichlidae				
Oreochromis niloticus	121	33.52	10890	33.36
Sarotherodon melanotheron	106	29.36	7314	22.40
Tilapia zilli	82	22.71	4510	13.81
Clariidae				
Clarias gariepinus	46	12.74	8740	26.77
Hepsetidae				
Hepsetus odoe	06	1.66	1194	3.66
Tot al	**361**	**100**	**32648**	**100**

DISCUSSION

Physico-chemical Parameters

The observed variations and significant difference in physicochemical parameters of the water at the different sampling stations indicate different anthropogenic activities in these areas. Water temperature range for Ureje Dam compares well with those recorded for other tropical lakes, this agree with the report of Adekole and Annune, 2003 on benthic macroinvertebrates as indicator of environmental quality of an urban stream.

The hydrogen ion concentration (pH) recorded in this study was neutral in the two sampling stations, and it was within the range for inland waters (pH 6.5 – 8.5) as reported by (Antoine and Al-Saadi, 1982) and Boyd and Lichtkoppler (1979) and for supporting aquatic life including fish. Environmental Protection Agency (EPA, 1976) recommended pH 6.5 - 8.5 for drinking and 6.0 – 9.0 for aquatic life. Thus the pH range recorded in this study is within the acceptable level of 6.0 - 8.5 for culturing tropical fish species (Huet, 1977) and for drinking water (WHO, 1984). Aquatic organisms are affected by pH because most of metabolic activities are pH dependent (Wang *et al.,* 2002), optimal pH range for suitable aquatic life is pH 6.5 – 8.5 (Murdock *et al.,* 2002). Fresh water ranges of pH 6.0 – 9.0 have been noted to be productive and thus recommended for

fish culture (Adeniji, 1981), outside this range, water may have sour taste and could be corrosive to metals.

Alkalinity is the measure of the capacity of water to neutralize or buffer acids using carbonate, bicarbonate ions, and in rare cases by hydroxide, thus protecting the organisms from major fluctuations in pH. The alkalinity values recorded in this study were within the recommended values between 5- 500mg/l (Lawson, 1995). High levels of alkalinity were observed in dry season than rainy season by Ibrahim *et al.,* (2009b) and Andem *et al*., (2012).

Dissolved oxygen (DO) is by far the most important chemical parameter in aquaculture. Low dissolved oxygen levels are responsible for most fish kills, either directly or indirectly, than all other problems combined. The dissolved oxygen value 6.70 ± 0.14 and 7.30 ± 0.04 recorded in deep and shallow sampling stations respectively in Ureje Dam indicated the water to be of good quality and will support fish production. Duodoroff and Fry (1959) recommended 5mg/l dissolved oxygen for warm fresh water fish species. Boyd (1979) reported that dissolved oxygen concentration of 3mg/L to 12mg/L will promote the growth and survival of fish in reservoirs. Oniye *et al.,* (2002) reported mean oxygen concentration of 0.17mg/l in Zaria Dam, while the following values has also been reported at various reservoirs 4.8 – 8.2mg/l in Oyun Reservoir (Mustapha, 2008), 4.7 – 9.8mg/l in Sabke Reservoir (Bala and Bolorunduro, 2011), 2.24 – 3.46mg/l in Ona River Apata, Ibadan and 0.7 – 1.8mg/l in Awba Reservoir (Anago *et al*., 2013)

Conductivity levels below 50µmhos/cm are regarded as low; those between 50-600µmhos/cm are medium while those above 600µmhos/cm are high conductivity (*Anago et al.,* 2013). Thus the range of 774.30 ± 5.90 to 840.75 ± 1.55µs/cm of electrical conductivity obtained in this study indicates high conductivity of the Ureje Dam when compared with findings of Mustapha (2008), Bala and Bolorunduro (2011) and Anago *et al*. (2013). A value above 50µS/cm but below 600µS/cm indicates medium conductivity of the Reservoirs. Boyd (1979) reported that natural water normally has conductivity ranges from 20- 1500µS/cm.

Phosphate recorded in this study was relatively high, this could occur as a result of allochthonous substances washed into the reservoir from runoffs from the surrounding farmlands, most which fertilizers have been applied to enhance good yield of crop plants (Akin-Oriola, 2003).

The mean nitrate content of the water was higher than the 10mg/L recommended by WHO/FEPA (1995) for drinking water and fish production. The mean value recorded for the nutrient (NO_3) is similar to those of Rivers Orogodo, Agbor, Delta State (Heleen*et. al.,* 1995). Higher values are often recorded during the rainy than dry seasons as observed by the afore-mentioned author. This may be due to flushing of some of the organic-bond nutrients from the drainage areas by runoffs created by the rains and from decaying plants and animal materials, agricultural fertilizers and domestic sewage. The high rate of influx of floodwater laden with organic matter and nutrients from surrounding landmass during the wet season, thereby makes it possible for nitrate to be carried in flood through the highly chemically fertilized soils to percolate the water body. Excess nitrates in drinking water at levels above 45 mg/L is a health risk for infants less than six months old (Ikomi *et. al.,* 2003). Drinking water containing more than 50 mg/L nitrate can cause methaemoglo-binemia in infants. Nitrate causes

overgrowth of algae, other organisms and fouls the water system. Epidemiological studies have also predicted association between exposure to nitrate and gastric cancer, because of the reaction of nitrate with amine in diet forming carcinogenic nitrosamine (Egereonu and Nwachukwu, 2005).

Fish Species Abundance

The study on fish species abundance of Ureje Dam revealed that six species of fish belonging to four families were recorded in the sampling station indicating low species abundance when compared with other studies on some of the man-made lakes in Nigeria, for example NARESCON (1992) reported that the fresh water fishery resources in Nigeria comprised of over 200 species from inland waters, with Kainji having about 100 species of fish while Lake Chad had 87 species. Ita (1993) reported 101 species of fish in Lake Kainji and 52 species in Jebba, eighteen (18) species belonging to nine families were recorded in Zaria reservoir (Balogun *et al.,* 2000). Balogun and Auta (2001) recorded nineteen (19) species of fish in Kangimi Lake, similarly Adeosun *et al.* (2011) reported 34 species of fish in Ikere Gorge, 32 species of fish were reported in Umudike water reservoir (Avoaja, 2011), while 19 species was reported in Erinle lake (Komolafe and Arawomo, 2011), 16 species reported in Ikwori lake (Offem *et al.,*2011) and 27 species in Asejere lake (Ipinmoroti, 2013). Other works with a comparable results to what was obtained in Ureje Dam include, for instance fourteen (14) species of fish were reported in Owena reservoir (Fapohunda and Godstates (2007), eleven (11) species recorded in Gbedikere semi oxbow lake, Oguma, seven (7) species of fish were reported inKontagora reservoir (Ibrahim, 2009). Dan-Kishiya *et al*, (2013) reported low diversity of fish species in Lower Usuma Dam, Bwari, Abuja of eleven (11) species of fish belonging to five (5) families, Ayanwale *et al.* (2013) reported seven species of fish in Tagwai lake Minna, while eight (8) species of fish were recorded in Egbe reservoir (Edward, 2013).

CONCLUSION

The mean values of the physico-chemical parameters of water obtained from Ureje Dam showed that they were within the acceptable ranges safe for drinking water and for fish culture. There were stations variation in some physico-chemical parameters in Ureje Dam, this observation may be due to the changes in climatic conditions and human activities around the Dam area such as flood from catchments areas and agricultural activities.

Six species of fish belonging to four families which are of economical values are present in Ureje Dam. The family Cichlidae formed the dominant family both in number and weight in the dam and also dominated the two major habitats (shallow and deep area) of the dam. *Oreochromis niloticus* was the most abundant fish species recorded in the experimental gillnet sampling of Ureje Dam. There were few fish species in Ureje Dam which indicate that the Dam may be over-exploited; as fishing was throughout the year in the reservoir, different types of fishing gears employed by the local fishermen were gillnets, cast nets of different mesh sizes, traps, hook and line were used without proper monitoring by the appropriate authorities. There were monthly and seasonal variations in the fish species composition of Ureje Dam; the family Cichlidae dominated the catches.

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EFFECTS OF STORAGE ON THE PHYSICOCHEMICAL PARAMETERS OF SELECTED SACHET WATER PRODUCED IN ADO-EKITI METROPOLIS, NIGERIA.

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ABSTRACT

The effects of storage on the physico-chemical parameters of sachet water produced in Ado-Ekiti metropolis had been carried out for a period of eight weeks. Samples of sachet water were collected from twelve different factories that produced the sachet water in Ado Ekiti after 24 hours of production and stored at room temperature. Sub-samples were taken from the bulkon weekly basis and analysed for some physico-chemical parameters using APHA methods of analysis. The results showed that pH generally increased in all the samples while other parameters decreased with the time of storage and still conformed to Nigerian Industrial and World Health Organization standards. Both Total Dissolved Solids and Electrical Conductivity had the highest % coefficient of variation and there is no significant difference between them at 95% confidence level. The health effects of the various parameters determined are discussed.

Keywords: sachet water, physico-chemical parameter, storage, water quality

INTRODUCTION

Bottled and sachet water are brands of packaged water which have become the most widely consumed liquid product not only in Nigeria but all over the world. The reason for the rapid consumption is probably due to lack of enough safe and accessible drinking water and when public water is available; the taste of chemicals used to disinfect the water will rebuff the person drinking it (Dada, 2009). It has been reported that bottled water is the fastest growing drink choice and its consumption in the world increased by average of 10%, thereby becoming the most dynamic sector of all food and beverage industries due to accessibility (Toma *et al.,* 2012). The people in urban areas have access to bottled water while majority in the rural areas have access to sachet water, however, the choice depends on individual level of finance and prevailing economy. Production, registration and certification of portable water production in Nigeria is regulated by National Agency for Foods Drugs Administration and Control (NAFDAC) in collaboration with World Health Organization (WHO) and Nigerian Industrial Standard (NIS).

There has been a tremendous improvement in water regulations because we now have a zero level of illegal producers in Nigeria and this is evident from the fact that water borne diseases have become the thing of the past. The major problem associated with packaged water is not always during the production but post contamination which is a function of the water itself, packaging material, and handling before, during and after production (Akinde *et al*., 2011). Under prolonged storage of packaged water, the parameters can change to a level that will make such water unfit for consumption. The technicalities in water treatment efficiency will now be under severe threat as total heterotrophic bacteria count can grow to a level that can be harmful to human beings (Warburton *et al*., 1992). In Nigeria, the expiring date on bottled water is a period of twelve months while that of sachet water is two months.

The aim of this study is to evaluate the effect of storage on physico-chemical parameters of some sachet water available in Ado-Ekiti metropolis in Ekiti-State of Nigeria stored over a period of time before their shelf- life.

MATERIALS AND METHODS

Twelve brands of sachet water with NAFDAC registration numbers were purchased from their respective factories in Ado-Ekiti metropolis in bags within 24 hours of production and stored in the laboratory. Sub samples were drawn from the bulk in duplicates for physico-chemical characterization using APHA, (1998) analytical methods. The physic-chemical parameters of the sachet water were analyzed immediately after collection and subsequently thereafter on weekly basis.

RESULTS AND DISCUSSION

The results of the pH value of the sachet water are presented in Figure 1. The pH values ranged from 6.69 to 8.35 throughout the period of investigation. pH values obtainedwere within Nigerian Industrial Standard which varied from 6.50 to 8.50 (NIS,2008 and WHO, 1996).Generally, an increase in pH was observed in all the samples as length of storage increases. The lowest pH was observed in Yopeky water in the first week while the highest was observed in Benruf water on the eighth week. This result is in agreement with the work ofIsikwuel and Chikezie, (2014)who analysed packagedwater from Bauchi Metropolis but in disagreement with the results of Ruma *et al*., (2014)who carried out analysis of water from Katsina urban area in Nigeria in which some of the samples were less than 6.50. It has been reported by World Health Organization that health effects are more pronounced at extreme pH (WHO, 1996). Drinking water with pH above 11 can cause skin, eye and mucous membrane irritation and a low pH value below 4 also led to irritation due to the corrosive effects of acidity (WHO, 1996).

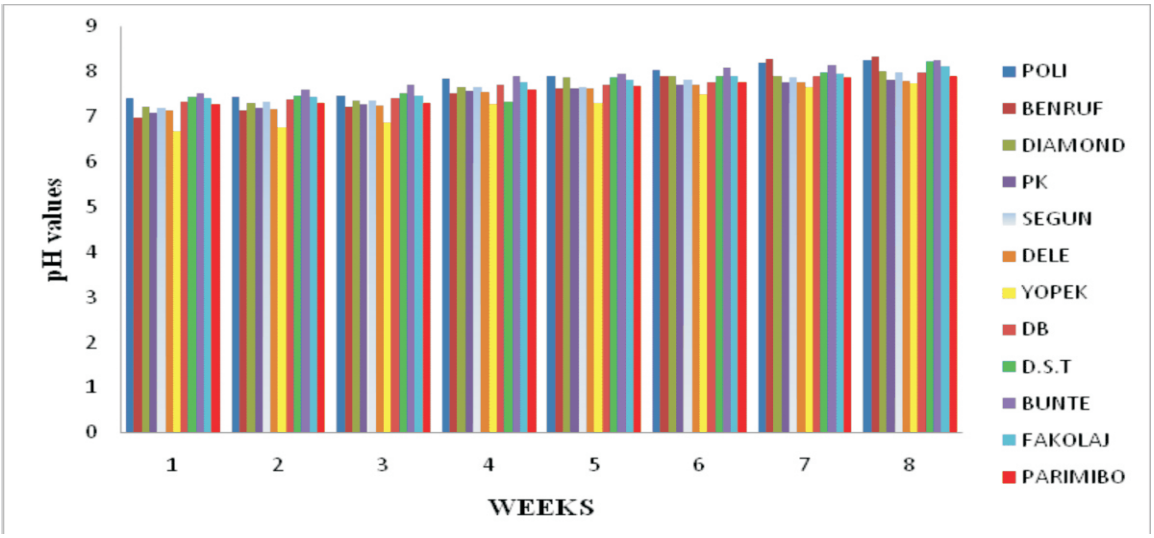

Figure 1: pH levels in the sachet water produced in Ado-Ekiti metropolis.

The results of Total Dissolved Solid (TDS) and Electrical Conductivity (EC) are presented in Figures 2 and 3 respectively. The lowest TDS was observed in Segun water and the highest in DST water. This trend was repeated in EC and all the water samples conformed to both WHO(1996) and Nigerian Industrial Standards (NIS, 2008) for drinking water.

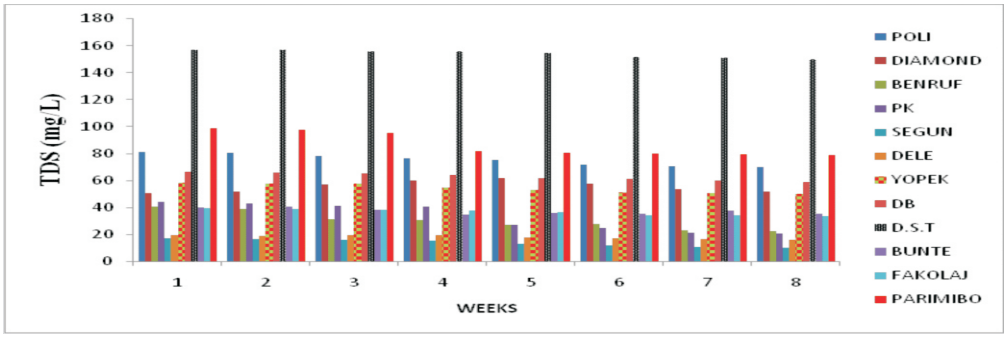

Figure 2: TDS levels in the sachet water produced in Ado-Ekiti metropolis.

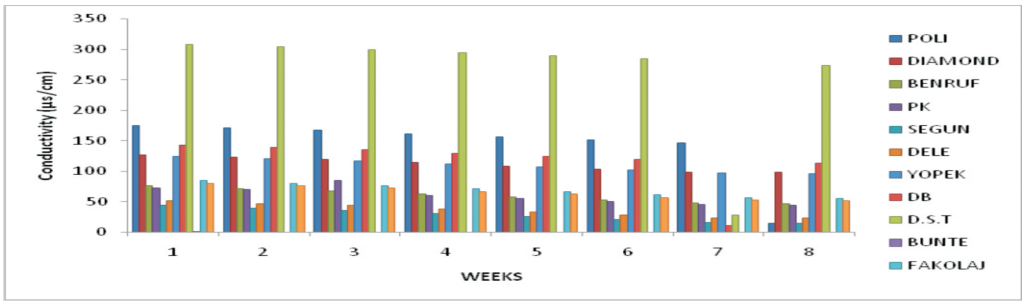

Figure 3: Conductivity levels in the sachet water produced in Ado-Ekiti metropolis.

TDS is a measure of the combined content of all inorganic and organic substances contained in water. Although it is not deemed to be associated with health effects, it is used as an indication of aesthetic characteristics of drinking water and as aggregate indicator of the presence of a broad array of chemical substances (Isikwuel and Chikezie, 2014). Electrical conductivity on the other hand is a measure of the ability of water to conduct electricity by giving a good idea of the amount of dissolved material in the water. Dissolved substances have been reported to affect suitability of water for drinking purposes as high levels could give unpleasant taste or odour (Atekwanaa *et al.,* 2004). The values of TDS and EC obtained from DST water though conformed to the NIS, but the appearance of taste and odour in the water could probably make the customers to reject the product. The values obtained could be attributed to salt concentration from the basement formation from the source of the water (Isikwuel and Chikezie, 2014).

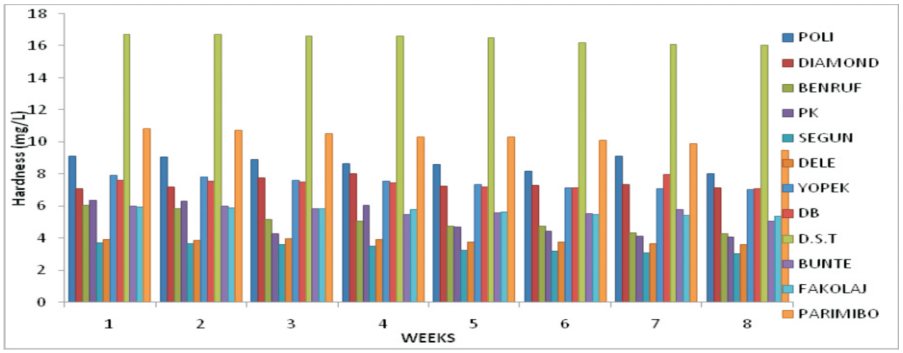

Figure 4: Total hardness levels in the sachet water produced in Ado-Ekiti metropolis.

The results of total hardness are presented in Figure 4. The results showed that the values obtained were lower than 20 mg/L within the period of study. Generally a decrease was observed in all the samples with increase in time of storage for eight weeks but still conformed to both NIS and WHO standards. This implied that all the water samples are considered safe for drinking in terms of hardness. Total hardness in water is an indication of the presence of calcium and magnesium salts. All the water samples in this study have been considered soft because the results are less than 20 mg/L (Ruma *et al.,* 2014). The taste threshold for the calcium ion has been reported to be in the range of 100-300 mg/L depending on the associated anion and such concentration or above it in water is acceptable to consumers for dietary supplements of calcium to promote strong bone and teeth (Pocock *et al.,* 1981). Thus the consumer should be informed of the mineral composition of the packaged water they are drinking.

Figure 5 shows the results of chloride for all the water samples. The lowest value was observed in Yopeky water with 14.6 mg/L while the highest was observed in Dele water with 57.8 mg/L. A general decrease was observed with time of storage. The high valuerecorded may be attributed to chlorination method used to reduce the risk of infectious diseases and water borne pathogen (Omalu *et al.,* 2010). The chemical was believed to be safe by destroying microbes but

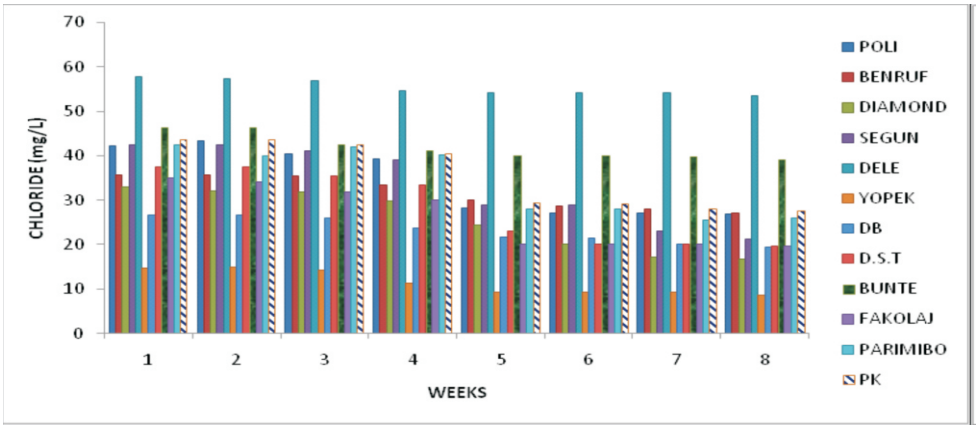

Figure 5: Chloride levels in the sachet water produced in Ado-Ekiti metropolis.

the formation of trihalomethanes could result in increased cancer risk. In addition to this, over chlorination could make the residual chlorine excess with increased chloride content and therefore impacts bad taste to packaged water.

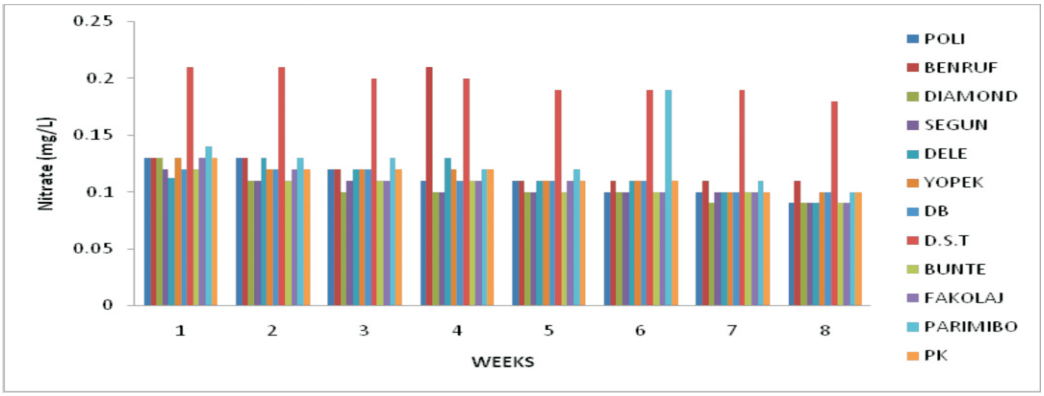

Figure 6: Nitrate levels of sachet water produced in Ado-Ekiti for a period of eight weeks

Nitrite was not detected in all the samples and could probably be due to the fact that they are short-lived because they are quickly converted to nitrates by bacteria while still in the aquifer (Isikwue and Chikezie, 2014). However, the nitrate level in all the samples was very low and within the NIS, 2008 permissible limit. Generally, there was decrease in the values from the first to eighth week. The acceptable limit in NIS is 1.0 mg/L. Nitrate levels at or above 10 mg/L has been reported to cause a potentially fatal blood disorder in infants leading to blue baby disease and diarrhea and vomiting (Olaoye and Onilude, 2009).

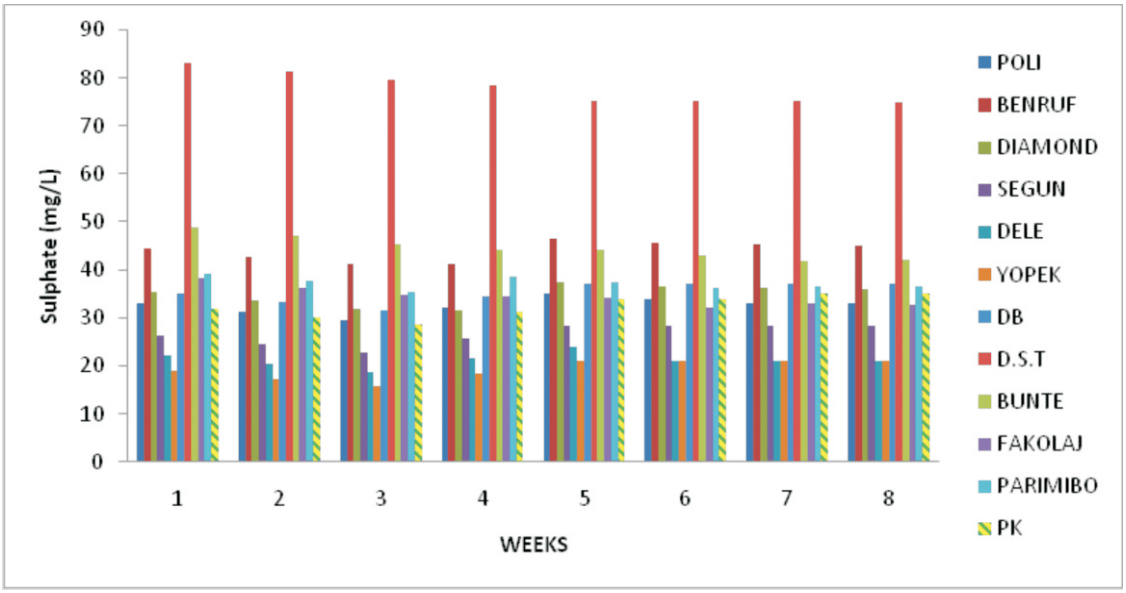

Figure 7: Sulphate levels in the sachet water produced in Ado-Ekiti metropolis.

The results of the sulphate are as presented in Figure 7 showed that Yopeky and Dele waters had the lowest values of 19.2 mg/L while DST had the highest values. All the water samples are below 100 mg/L recommended by NIS and therefore within the established standard. Sulphate and hydrogen sulphide are the two forms of sulphur commonly found in drinking waterwith little or no health risk at concentration found in domestic water supply (Omalu *et al*., 2010).

Conductivity had the highest % coefficient of variation which ranged from 58.8 to 78.1% while pH had the lowest % coefficient of variation which varied from 2.04 to 3.18%. This implied that conductivity had the highest levels of variation out of all the parameters studied. However, there is no significant difference at 95% confidence level between the results of TDS and EC.

CONCLUSION

Drinking water is needed for survival without which there is no life. The qualities of some sachet water were assessed to find out the changes that took place after production and monitored at room temperature for eight weeks. While the values of some parameters increased, others decreased with storage but fall within the acceptable limit of NIS. However, the quality of some of the water could be improved with the use of modern nanotechnology and reverse osmosis equipment during treatment.

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NUTRITIONAL EVALUATION OF COOKIES PRODUCED FROM CASSAVA PRODUCT ENRICHED WITH GROUNDNUT CAKE

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Abstract

Cookies produce from blends of cassava product and groundnut cake was evaluated for the proximate composition, mineral composition and sensory attributes. From the result it was observed that the proximate composition of the samples ranged as follows: 8.39 to11.75%; 8.08 to 9.67 %; 4.12 to 7.15%; 4.87 to 10.48%; 1.24 to 9.14%; 58.79 to 69.84%; 338.68 to 386.68 calorie for moisture, protein, ash, fat, crude fibre, carbohydrate, energy value respectively. The highest percentage of protein and ash were determined in the sample E having the highest ratio of groundnut cake. More so, Sodium content ranged between 58.50 -115.20 (mg/100g), calcium content ranged between 81.31 -214.63 (mg/100g), iron content ranged between 0.32 -13.24 (mg/100g), manganesecontent ranged between 0.183 - 2.743 (mg/100g), zinc content ranged between 0.231-1.855 (mg/100g) and that of phosphorous content ranged between 50.353 -75.70 (mg/100g) in which the highest value of each of these minerals was noticed in Sample E. However, variation in the groundnut cake level and some other ingredients does not influenced the organoleptic properties of the cookies.

1.0 Introduction

Cassava roots are a staple food that provides carbohydrates for more than 2 billion people in the tropics. However, cassava roots spoil quickly after harvest. In orderto avoid this loss, they must be sold or processed into by-products after harvest. Generally, cassava and its products are poor in proteins. The deficiency in certain essential amino acids depends mostly on the varieties and geographical conditions. In order to enhance the nutritional quality of cassava, it is processed into fermented products such as gari. It is one of the most popular cassava products consumed in Africa, Southeast Asia, and Brazil (Ola. *et al.,* 2016). In Africa, fermented foods and beverages are produced using fermentation. These products have been consumed for a long time because of their numerous nutritional values. It is a creamy white, granular flour with a slightly fermented flavor and slightly sour taste (Oboh, 2006). It also enhances micronutrient bioavailability and aids indegrading antinutritional factors . About 83% of the total cyanogenicglucosides (linamarin and lotaustralin) are detoxified during processing of cassava tuber into gari (Tetchi, *et al.,* 2012). Gari being a staple food, it is made frompeeled, washed, grated, fermented and roasted fresh cassava tuber *(Manihot escuelentacrantz)* (Ernesto *et al.,* 2000). It is the most popular fermented cassava products in Africa (Oluwole *et al.,* 2004) and it is consumed by several millions of people in West Africa where it forms major part of their diet. In Nigeria,its acceptability cuts across the various ethnic and socio-economic classes, making it the commonest food among the rich and the poor (Jekayinfa*et al.,* 2007). Garriis

stored and marketed in a ready-to-eat form and prepared into a stiff paste or dough-like called 'Eba' by adding the granules into hot water and stirring to make apaste of varied consistency. Eba can be consumed with local soups or stews of various types by chewing or swallowing in morsels (Ugwu*et al.,* 2008). Gari can also be deliciously consumed directly (without cooking) with groundnut, smoked fish, coconut, cowpeas, moimoi, kuli-kuli, or taken as a fast food when soaked in cold water . Sometimes, it is taken with beverages mixed with cold water or warm water with salt or sugar depending on the choice of the individual.Garri is rich in starch, has high fibre content and contains some essential vitamins. Its high fibre content makes it very filling and, in the prevention or at least in reducing the likelihood of constipation and bowel diseases (Nyorere and Iweka, 2019). Enriching gari with groundnut cake has actually play a vital role in thebetterment of our daily meal. Groundnut cake (*kulikuli)* is a groundnut-based snack indigenous to the West African coasts. Being a snack, it is consumed by all agerange but more specifically by school-age children and the middle aged. It is also used as a majoringredient in poultry feed formulation (Ugwu*et al.,* 2008). Kulikuli is usually produced from groundnut during groundnut oil extraction or otherwise, and it is simply regarded as the fried residue obtained from this process(Akano*et al.,* 2002). It has been reported to be rich in protein and crude fat similar to its parent material, groundnut (Ugwu*et al.,* 2008). Although groundnut cakeis consumed by humans across some West African states, only very few data are currently available on this food material in terms of its safety and nutritional status.

Interestingly, the available data originate from Nigeria shows that it has appreciable amount of protein, hence a better nutritive attribute in our daily meal. Kulikuli is known to be mostly consumed by the low-income populace especially in Nigeria and therefore not seen as a major food.Cookies can also be produced from the gari-groundnut cake blends. This will be a convenient snacks product dried to a very low moisture contentwhich could be taken among young people and adult to reduce protein mal-nutrition and provide energy. This will provide an excellent means of improving thenutritional quality of foods through incorporation of less expensive high-quality protein source, minerals, vitamins and has been employed in food product enrichment. (Akano*et al.,* 2002). The objectives of this research work are to diversify the usage of gari and groundnut cake by producing cookies from theirblends, to determine proximate, minerals composition of the cookies produced and to evaluate the sensory attributes of the products.

2.0 Materials and Methods

2.1 Materials

Cassava product (gari), groundnut cake and other ingredients such as milk, sugar, corn starch, were purchased at Oja-Oba market in Ado-Ekiti, EkitiState.

2.1.1 Preparations of samples

All the recipes were mixed together in a bowl that was big enough to enable homogenizing of the materials by rubbing them within palmafter which water was added (10 ml at interval up to 50 ml) so the mixture to form dough. The dough was kneaded on a flat rolling board with the aid of a rolling pin so that it would make a flat spread. Shape cutter was then used to cut into desire (2-mm thickness) shapes later baked using hot air oven at 120 degree for 30 min.

2.1.2 Formulation of samples

Ingredients	Sample A	Sample B	Sample C	Sample D	Sample E
Garri	100g	100g	100g	100g	100g
Milk	8g	16g	24g	32g	40g
Groundnut cake	10g	20g	30g	40g	50g
Sugar	15g	15g	15g	15g	15g
Corn starch	15g	15g	15g	15g	15g

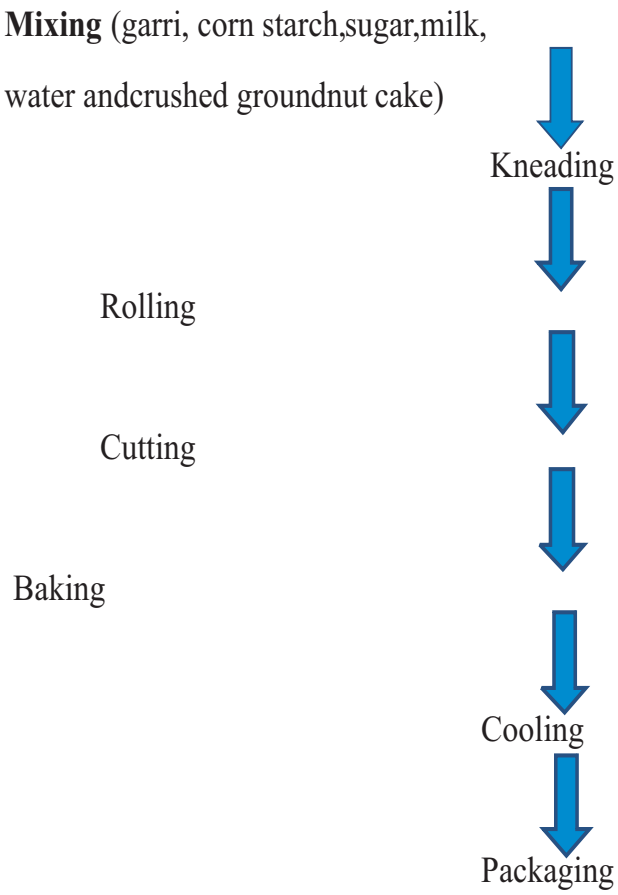

Fig 1: Flow chat for the production of cookies from gari.

2.2

Proximate and mineral composition were determined according (AOAC, 2000) while thesensory attributes were evaluated using nine-point hedonic scale.

3.0 Results and Discussion

Table 1: Proximate Composition of Cookies Produced fromGari and Groundnut cake

sample	Moisture (%)	Protein (%)	Ash (%)	Fat (%)	Fiber (%)	CHO (%)	Energy (calorie)
A	8.39±0.28^{d}	8.08±0.04^{d}	4.12±0.01^{d}	8.33±0.01^{d}	1.24±0.03^{e}	69.84±0.28^{a}	386.68±1.05^{a}
B	10.55±0.02^{c}	8.34±0.13^{c}	4.87±0.01^{c}	4.87±0.10^{e}	9.14±0.01^{a}	65.37±0.04^{b}	338.68±1.05^{d}
C	10.98±0.03^{b}	8.92±0.00^{b}	5.08±0.01^{b}	9.88±0.00^{c}	2.08±0.06^{c}	63.07±0.06^{c}	376.84±0.25^{ab}
D	11.74±0.01^{a}	9.65±0.01^{a}	7.14±0.01^{a}	10.33±0.02^{b}	2.33±0.01^{b}	58.79±0.01^{d}	356.79±1.73^{c}
E	11.75±0.00^{a}	9.67±0.02^{a}	7.15±0.01^{a}	10.48±0.01^{a}	1.97±0.01^{d}	58.98±0.01^{d}	368.93±1.84^{bc}

Values are means of triplicate determination.
Values with the same column followed by different superscript are significantly ($p<0.05$) different.
Key:
SampleA = 100g of garri, 8g of milk, 10g of groundnut cake, 15g of sugar, 15g of corn starch
Sample B = 100g of garri, 16g of milk, 20g of groundnut cake, 15g of sugar, 15g of cornstarch.
Sample C = 100g of garri, 24g of milk, 30g of groundnut cake, 15g of sugar, 15g of corn starch
Sample D = 100g of garri, 32g of milk, 40g of groundnut cake, 15g of sugar, 15g of corn starch
Sample E = 100g of garri, 40g of milk, 50g of groundnut cake, 15g of sugar, 15g of corn starch

Table 2: Mineral composition (mg/100g) of cookies produced from gari and groundnut cake.

Sample	Sodium	Calcium	Iron	Manganese	Zinc	Phosphorous
A	58.80±0.02^{e}	110.70±2.34^{b}	0.32±0.05^{e}	0.183±0.03^{e}	0.231±0.05^{e}	50.353±0.03^{d}
B	86.51±0.08^{c}	92.50±0.04^{d}	1.28±0.00^{d}	0.346±0.02^{d}	0.521±0.05^{d}	70.408±0.01^{b}
C	63.81±0.06^{d}	81.31±0.04^{e}	2.15±0.01^{b}	0.424±0.03^{c}	0.693±0.03^{c}	72.172±0.02^{b}
D	90.51±0.01^{b}	105.03±0.06^{c}	1.86±0.02^{c}	0.777±0.01^{b}	1.023±0.03^{b}	66.185±0.02^{c}
E	115.20±0.05^{a}	214.63±0.05^{a}	13.24±0.03^{a}	2.743±0.02^{a}	1.855±0.02^{a}	75.762±0.02^{a}

Values are means of triplicate determination.
Values with the same column followed by different superscript are significantly ($p<0.05$) different.
Key:
SampleA = 100g of garri, 8g of milk, 10g of groundnut cake, 15g of sugar, 15g of corn starch
Sample B = 100g of garri, 16g of milk, 20g of groundnut cake, 15g of sugar, 15g of cornstarch.
Sample C = 100g of garri, 24g of milk, 30g of groundnut cake, 15g of sugar, 15g of corn starch
Sample D = 100g of garri, 32g of milk, 40g of groundnut cake, 15g of sugar, 15g of corn starch
Sample E = 100g of garri, 40g of milk, 50g of groundnut cake, 15g of sugar, 15g of corn starch

Table 3: Sensory Evaluation of Cookies Produced from Gari and Groundnut Cake

Sample	Aroma	Taste	Color	Crispiness	Overall acceptability
A	6.80±0.78[a]	7.00±0.82[a]	6.90±1.29[a]	7.10±1.73[a]	7.80±1.62[a]
B	6.10±1.45[a]	6.90±1.10[a]	6.70±1.25[a]	7.00±1.70[a]	7.70±1.34[a]
C	6.50±2.22[a]	6.40±1.84[a]	6.30±1.06[a]	7.10±0.57[a]	8.40±0.70[a]
D	7.40±1.35[a]	7.40±1.07[a]	6.60±1.17[a]	7.30±1.42[a]	8.20±0.92[a]
E	7.00±1.94[a]	6.90±1.66[a]	7.10±1.70[a]	6.80±1.32[a]	8.10±0.10[a]

Values are means of triplicate determination.
Values with the same column followed by different superscript are significantly ($p<0.05$) different.
Key:
SampleA = 100g of garri, 8g of milk, 10g of groundnut cake, 15g of sugar, 15g of corn starch
Sample B = 100g of garri, 16g of milk, 20g of groundnut cake, 15g of sugar, 15g of cornstarch.
Sample C = 100g of garri, 24g of milk, 30g of groundnut cake, 15g of sugar, 15g of corn starch
Sample D = 100g of garri, 32g of milk, 40g of groundnut cake, 15g of sugar, 15g of corn starch
Sample E = 100g of garri, 40g of milk, 50g of groundnut cake, 15g of sugar, 15g of corn starch

3.1 Discussion

3.1.1 Proximate Cookies Produced from Gari and Groundnut Cake

Proximate composition was shown table 1. Sample (E) had the highest moisture content with the value of 11.75% compared to sample A which had the lowest moisture content of 8.39% respectively which was higher than the value obtained by what was reported by (Udoro*et al.,* 2014) who obtained a value ranging from 7.31 to 11.04% for normal gari which was lower than sample E but similar to that of sample A, The increased in the moisture content in sample E might be as a result of the added kulikuli (groundnut cake). It had been known that sample with highest moisture content is liable to deterioration and therefore leads to shorter shelf life. Sample A and E are significantly ($p>0.05$) different as they contain different superscript. Sample with the highest moisture content will be prone to deterioration due to microbial spoilage. Fat content ranged from 8.334 to 10.482%. The value obtained by (Udoro*et al.,*2014) was lower this was due to the groundnut cake added to it. (Udoro*et al.,*2014) obtained ranging from 0.34 to 1.36% for gari only. The highest fat content was noticed in sample E while the lowest was observe in sample A. The increase in fat content in sample E might be due to high percentage of groundnut cake present compared to sample A which had the lowest percentage of groundnut cake. High fat in food helps to produce more calories in the body which can be utilized as a source of energy. Although, the sample with the highest fat content will be prone to rancidity. Fiber content of sample B was higher than that of the other samples while sample A had the lowest fibre content which ranged between (1.243– 9.136%). The samples were significantly ($P<0.05$) different from one another. The high fibre content of sample B was due to the high percentage of groundnut cake compared to sample A. Food with high fiber helps to

extend the colony cell wall and thus improve the passage of waste and act as an anti-constipation. The protein content in sample E was rated the highest (9.67%) while sample A had the lowest value of (8.08%) which were both higher than what was reported by (Udoho *et al.,* 2014), for cassava product (gari) ranging between (1.22 to 1.69%). The increased in protein content was a result of the added groundnut cake and milk. Food with high protein helps to build the body. The increased protein was due to high percentage of milk and ground nut cake in it. Ash content is an indication of high minerals content in food. Ash content ranged between (4.118–7.146%). The increased in ash content of sample E was due to high percentage of the ingredient used. As it had been known that legumes are rich in minerals compared to other food groups. Ash content of the samples were significantly different ($P<0.05$) from one another except for sample D and E that were significantly different ($P>0.05$) from each other. Carbohydrate value ranged between (58.79–69.84%) but low when compared with what was obtained (82.38 to 86.48%) by (Udoho *et al.*, 2014) for gari. Sample A had the highest carbohydrate content. Energy value ranged between 338.66–386.68 calorie. Sample A which had the highest carbohydrate content had the highest energy value.

Minerals composition was shown in table 2. The calcium content (214.63ppm) obtained in sample E was significantly ($p>0.05$) higher than the one obtained in other samples and the value obtained by (Oko*et al.,* 2014) for cassava product (gari). Calcium content ranged between 92.50–214.63ppm. Sample E had the highest sodium content which ranged between 58.801-115.20ppm. Although, the value obtained in sample A which was even the lowest was still higher than the value (0.22ppm) obtained by Oko*et al.,* (2014) for gari as a cassava product. Manganese ranged between 0.183– 2.743 ppm. The highest manganese content was observed in sample E which could be as a result of high percentage of milk in the recipe compare to other samples while the lowest content was in sample A. Iron content in the samples ranged between 0.316–13.242ppm. The Iron content obtained in sample E (13.242ppm) was higher than the value (1.30ppm) obtained by (Oko*et al .,* 2014). Phosphorous content ranged between 50.353– 75.762ppm. Sample E had the highest phosphorous content while sample A had the least. Zinc content in the samples ranged between 0.231–75.762ppm. It was observed that sample E had highest mineral content across the samples.

Sensory evaluation carried out include Aroma, Taste, Color, Crispiness and Overall acceptability was shown in Table 3. The value of aroma ranges between 6.10-7.00. Sample D was rated best among other samples while sample B was rated least. There was no significant ($P>0.05$) difference among the samples. Sample D was rated best for taste, taste value ranges between 6.40– 7.40 of which sample C had the least taste content value. Colour is an important factor that facilitate the consumer's preference for product acceptability. Sample E was rated best with a value of (7.10) while sample C had the least colour value. Sample E had the best color because it had the highest milk and groundnut cake percentage compare to others which facilitates its brown colour. Crispiness range between (7.00- 7.30). The whole samples were not significantly different as they contain the same superscript. Sample D was rated best in crispiness compared to sample B which had the least crispiness value. Overall acceptability value ranged between (7.70-8.40). Sample C was the most overall acceptable sample as it had the highest value of (8.40), although was not significantly ($P>0.05$) different from other samples.

Conclusion

The consumption of gari in most communities are sometimes seen as an indication of poverty and also seen as a food of no nutritional value. Enriching this cassava product will help in preventing the deficiency of protein in the body. Being a product of a popular stable food, gari-cookies could go a long way in ameliorating mal-nutrition, especially in children, global acceptance of gari would undoubtedly be enhanced through increasing the number of products obtainable from it. This new improvement in garri will help to balance the diet and prevent protein-energy mal-nutrition among the children and adult.

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NUTRITIONAL VALUE AND SUPERIORITY OF YELLOW - FLESH CASSAVA TUBER PRODUCT

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Abstract

Cassava became the most important root crop in the tropical Africa, is the most advanced component of root and tuber crops production in Nigeria. More than 10 million smallholders grow cassava and over 50 million people earn their living directly or indirectly from it. Consumption of yellow gari in many households of Nigeria has become traditionally acceptable table diet because of it richness in vitamin A content that reduces the effect of vitamin A deficiency. Vitamin A deficiency has affected 20% of pregnant women, 13% of nursing mothers and 30 % children under 5 years. This study emphasized nutritional composition of a food sample (yellow eba) such as carbohydrate, protein, vitamin, minerals and a good source of energy using proximate analysis. The findings revealed that 2.1 % protein, 0.5 % fat, 0.4 % fibre contained in the sample. Almost 19.0 % carbohydrate with adequate proportion of minerals contents present for our healthy growth. The high beta-carotene (131.25±0.79 µg/g) and vitamin A (21.88±0.13 µg/g) in the sample is a reflection that yellow eba supplies appreciable and significant amount of intake of bio- available vitamin A. consuming yellow eba provides a number of desirable nutritional and health benefits such as vitamin A which reduces effects of vitamin A deficiency for human well - being. However, alternative and more favorable policy that would negate more devastating effects of the Coronavirus (COVID - 19) is expected to protect food production and food security.

Key words: affluent, bio - fortified, calories, carotene, clones, immunity and mortality

Introduction

Cassava has great potential as a dietary energy source for man and livestock, is likely to produce more food calories per unit area than any other lowland crops grown in Nigeria. It supplies 70 % of the total calories intakes of about 60 million people in Nigeria (*Ogbuekiri et al. 2014*). Cassava has become the most advanced component of root and tuber crop production in the country with the ability and encouragement of farmers to integrate science and technology into production. In the last decade consecutively, Nigeria has been rated as the world leading producer of cassava followed by Indonesia, Thailand and Democratic Republic of Congo (Adegbite, 2018). Assessing the potential of new clones of making various traditional foods such as *gari* and *fufu;* which are common in Central and West Africa are white and yellow types. But because of its high carotene content, *yellow gari* is more nutritious than white (Bouis, 2011). However, bio-fortified yellow cassava has great potential to alleviate vitamin A deficiency in Sub-Sahara Africa*(Egesi, et al. 2010).*

Gari is very important in an average Nigerian's every day diet due to its nutritional value, convenience and cost competitiveness. It is mainly produced from cassava tuber as a major raw material. Cassava becomes important composite flour made from tropical root and tubers for good quality bread production while

reducing cost of wheat importation in Nigeria *(Ijah et al. 2014)*.

Consumption of vitamin A rich food has beneficial effects on vitamin A deficiency (VAD). This study emphasized nutritional composition of a food sample *yellow eba* such as carbohydrate, protein, vitamins, minerals and a good source of energy. Consumption of *yellow eba* will not only lower the effect of vitamin A deficiency but boost our body immunity, renews vision and reduce death mortality particularly among children and older ones. A number of studies have been carried out on the nutritional status of vulnerable groups the country to improve dietary quality and health singly and independently. According to*Mazia-Dixon et al (2004)* nationally, 42 % of children were stunted, 25 % were underweight and 9 % were wasted. Also in 2011/2012 from Delta state in Nigeria, the children consuming cassava as their staple food were at greater risk to inadequate dietary protein intake as well as inadequate dietary intake of Iron (Fe) and vitamin A than those in affluent families who had more options for balanced diets. Hence, in an attempt to supplement dietary status in Nigeria,the poultry sub-sector which has been able to inject over 25 % of Agricultural Gross Domestic Products (AGDP) in the Nigerian economy in 2020 should be sustained so as to continue augmenting the source of additional protein intake for average Nigerians. However, alternative and favorable policy that would negate more devastating effects of the Coronavirus (COVID - 19) is expected to sustain food production and food security in Nigeria.

Methodology

The processed *yellow gari* was used to prepare food sample *yellow eba* and this sample is packed in nylon and stored at normal room temperature for proximate analysis test at the Department of Food and Science Technology, Obafemi Awolowo University, Ile - Ife. The moisture fat, ash, fibre and crude protein was carried out using standard method (AOAC, 1975). The total carbohydrate was obtained from the sample while iron (Fe), calcium (Ca), potassium (P), and sodium (Na) were determined using atomic absorption spectrophotometric flame photometric method as *Fashakin et al (2006)* reported.

Moisture

Moisture content was determined by the standard method using 1 g (w_1) of the sample in a hot air-oven (Uniscope, SM 9053, England) at 105±1 °c until constant weight (w_2) was obtained. The result is expressed in percentage as in the equation I.

$$M.C = \frac{w_1 - w_2}{w_1} \times 100 \qquad \text{eq}\ldots\ldots\ldots\ \text{i}$$

Note: MC = Moisture content, w_1 = mass of sample before drying (g),

w_2 = mass of sample after drying (g)

Ash

Ash content was determined by the official method using muffle furnace (Carbolite AA1100, United Kingdom). 2 g (w_3) of the sample was weighed into weighed (w_2) ashing crucible and placed in muffle furnace chamber at 700 °c for 3 hrs for the sample to turn into ashes. The crucible was removed cool and weighed (w_1) as in equation ii.

$$A.C = \frac{w_1 - w_2}{w_3} \times 100 \qquad \text{eq}\ldots\ldots\ldots\ \text{ii}$$

Crude fibre

Fibre was determined by standard using 2 g (w_3) of the sample. Surphuric acid was added at 200 ml of 1.25% (v/v) H_2SO_4 and boiled for 30 min. The content was filtered using filter paper (Whiteman No 1) and the residue on the filter paper was washed with 50-70 ml distilled water. The washed

residue was transferred back into the flask containing (v/v) NaOH and boiled for 30 min. It was filtered again and the residue was put into a dish and dried for 130 °c for 2 hrs, cooled and weighed (w_1). It was later ash 550 °c for 30 min, cooled and reweighed (w_2). The difference is hereby expressed as percentage in the equation.

$$C.F = \frac{w_1 - w_2}{w_3} \times 100 \qquad \text{eq}\ldots\ldots\ldots \text{iii}$$

Note: AC= Ash content, w_1 = mass of crucible + dried residue (g)
w_2 = mass of crucible + ash (g), w_3 = mass of sample (g)

Crude Protein

The total protein content was determined using the Kjeldahl method.[3] Ground sample 0.02 g was weighed into Kjeldahl flask, 10 milliliter concentrated sulphuric acid was added followed by one Kjeltee tablet (Kjeltee-Auto 1030 Analyzer, USA). The mixture was digested on heating rocket to obtain a clear solution. The *digestate* was cooled and made up to 75 ml with distilled water and transferred onto Kjeldahl distillation set, followed by 50 ml of 40% sodium hydroxide (NaOH). The ammonia formed in the mixture was subsequently distilled into 25 ml of 2% boric acid solution (prepared by dissolving 100 mg of methyl red in 100 ml methanol) indicator. The distillate collected was titrated with 0.05 M HCL. Black determination was carried out by excluding the sample from the above procedure. The equation is given as

$$CP = \frac{1.401 \times M \times F\ (\text{ml titrant} - \text{ml black})}{\text{Sample weight}}$$

Note: CP = Crude protein, M = Molarity of acid used 0.05mol/dm), F = Kjeldahl factor (6.25)

Fat

Fat was also determined using Soxhlet apparatus (Sunbim, India). Approximately 5 g (w_3) of the ground sample was placed into a thimble which was placed inside Soxhlet extractor and n-hexane was pureed into a pre-weighed round bottom flask (w_2), used to extract the oil from the sample. The extraction was carried out for about 6 hrs, later the solvent was removed from the extracted oil by distillation. The oil in the flask was further dried in a hot-air oven at 90 °c for 30 min to remove residual organic solvent and moisture. The weight of content (w_1) was taken and cooled in a desecrator.

$$Fat = \frac{w_1 - w_2}{w_3} \times 100 \qquad \text{eq}\ldots\ldots\ldots\ldots \text{v}$$

Note: $w_{1=}$ weight of fat + oil, $w_{2=}$ weight of empty flask, $w_{3=}$ weight of sample

Carbohydrate.

Carbohydrate was expressed as a percentage of the difference between the addition of other proximate chemical compounds and 100% as in the equation.

Carbohydrate = 100 – protein + crude fat + ash + fibre + moisture

Note: all experiment was conducted in trip late and the mean and standard deviation were calculated.

Beta-carotene and vitamin A

About 5 g of sample was placed in conical flask containing 25 cm^3 of 90% of ethanol and maintained at a 60 - 80 °c in a water bath for 20 min with periodic shaking. The extract was decanted, allowed to cool and it volume was measured by measuring cylinder and recorded as volume (V_1). The ethanol concentration of the sample was brought to 85% by adding 7.5 cm^3 of

distilled water and allowed to cool in a container of ice water for 5 min. into a separate furnel, 12.5 cm^3 of petroleum ether (pet-ether) were poured and cool; ethanol extract was added to obtain homogenous mixture and allow standing until separate layers were obtained. The bottom layer run into a beaker while the top layer was collected in 250 cm^3 conical flask. The bottom layer was returned to the separate furnel and re-extracted with some of the pet-ether for 5 min until the ethanol extract becomes fairly yellow. The entire pet-ether extract was collected into 250 cm^3 conical flask and returned into separating furnel for re-extraction with 25 cm^3 at 85% ethanol. The final extract (the clear layer) was measured and pour into sample bottle for further analysis.[4] However, the absorbance of the extract was measured by Spectrophotometer, sample of each extract was placed in a cuvette containing pet-ether and reading was taken when the figure becomes steady. The operation was repeated three times for each sample and beta-carotene was calculated from the calibration curve of the standard. After the concentration of beta-carotene was calculated; the vitamin A (Retinol) was also calculated using this:

6µg of beta-carotene ## 1µg of retinol equivalent

Results

Table 1: Proximate Analysis of *yellow eba* Prepared from *yellow gari*

Component	Calorific Value (%) Yellow Food Sample
Moisture content	77.80±1.03
Ash	0.35±0.02
Fibre	0.43±0.02
Crude protein	2.09±0.04
Fat	0.52±0.03
Carbohydrate	18.75±1.08

Source: Laboratory treatment, FST, OAU, 2018

Table 2: Proximate Analysis of Mineral Composition of *yellow eba*

Minerals	Mineral Composition (mg/100g) Yellow Food Sample
Iron (Fe)	7.77±0.57
Calcium (Ca)	22.80±0.46
Potassium (K)	301.02±1.46
Phosphorous (P)	12.70±0.35
Sodium (Na)	283.49±2.81

Source: Laboratory treatment, FST, OAU, 2018

Table 3: Proximate Analysis of vitamin A and beta - carotene

Contents	y*ellow eba* (µg/g)
Carotene	131.25±0.79
Vitamin A	21.88±0.13

Source: Laboratory treatment, FST, OAU, 2018

Discussion

The findings in the Table 1 revealed that 2.1 % protein content contained in the food sample which is an evidence that,*yellow eba*is enough to contribute to the proportion of protein intake of households as a better alternative source of protein supplement at this period when egg and poultry meat become too expensive and unaffordable to many households in Nigeria. About 0.5 % of fat content and high fibre content (0.4 %) were present in the food sample. The importance of this finding is that, the presence of fat content which believed to be higher than food sample made from *white gari* has the tendency to increase palatability of the food, absorbing and retaining flavor. More importantly, presence of fibre content in a food sample facilitating *faccal* elimination that is being helpful in dealing with diverticular diseases and cancer of small intestine *(Leed et al. 1979)*. It further shown that 0.4 % of ash content which is a good sign of better amount of essential minerals contained. Though the carbohydrate (18.8 %) content may be lower when compare it to that of *white eba* but it is an indication that the food sample is rich in nutrients and could supply the useful body requirement for human physiological and psychological growth since it has been proved to be highly nutritious. The result is not contradict the finding at (FIIRO, 2006).

The result in the Table 2 revealed that *yellow eba* contains (22.80±0.46) mg/100g calcium, (301.02±1.46) mg/100g potassium, sodium (283.49±2.81) mg/100g, and appreciable level of phosphorous (12.70±0.35). The quantity of minerals contents contained in the food sample is a reflection that *yellow eba* is a good source of essential minerals though deficient in iron (Fe) content (7.77±0.57) mg/100g, which justifies the finding of *Salzmanet al. (2013)* who discovered that yellow tuber cassava is a good source of nutrients but generally low in Iron (Fe) and Zinc (Zn) contents. *Yelloeeba*as dietary food provides a number of desirable nutritional and health benefits such as vitamin A. It is therefore observed that *gari* is a widely consumable food item in many households in Nigeria and it implies that many growing up children and women have adequately accessed these mineral nutrients cheaply.

The result in the above Table 3 revealed that (131.25±0.79 µg/g) of beta - carotene and (21.88±0.13 µg/g) of vitamin A are present in the food sample. The indication of the result is that *yellow eba* supplies appreciable and significant amount of beta - carotene required for growth if consumed. Appreciable amount of beta – carotene is a precursor to vitamin A which is a clear indication for alleviating vitamin A deficiency in Nigeria.

Conclusively, *yellow eba*may be deficient in most other vitamins and minerals but it contains significant amounts of dietary fibre. Yes, it could be adopted as a food-based strategy approach to enhance massive intake of vitamin A for the purpose of improving nutritional intake status of individuals and reduces micro-nutrient malnutrition in our society.

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EFFECTS OF COMPUTER ASSISTED CONCEPT MAPPING AND COMPUTER ASSISTED ANALOGICAL INSTRUCTIONAL MODEL ON SECONDARY SCHOOL STUDENTS' ACHIEVEMENT IN CHEMISTRY.

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Osun State

Abstract

This study investigated the effects of computer assisted concept mapping and analogical instructional models on secondary school students' achievement in Chemistry. The purpose of the study was to determine the difference in achievement of the concept of chemical equilibrium among secondary school students exposed to Computer Assisted Concept Mapping Instructional Model (CACMIM) and Computer Assisted Analogical Instructional Model (CAAIM) and those exposed to conventional method. The study adopted pre-test post-test control group quasi experimental design. The sample for the study comprised 284 Senior Secondary School Two (SSS2) chemistry students drawn from nine intact classes of purposively selected co-educational public Senior Secondary Schools. The instrument used for this study was Chemistry Achievement Test (CAT) which consisted of 50 multiple choice test items on Chemical Equilibrium. The instrument was given to chemistry teachers, the researcher's supervisor and experts in Test and Measurement to ascertain face and content validity. A test-retest method was used to determine the reliability of the CAT on 30 Senior Secondary School students in Osun State who were not part of the sample used for this study. However, the reliability coefficient of 0.75 was obtained using Pearson Product Moment Correlation Analysis. The general questions were answered using mean and standard deviation while the hypotheses were tested using Analysis of Variance (ANOVA), Analysis of Co-variance (ANCOVA) and Multiple Classification Analysis (MCA). The result of the study revealed that the achievement of students in the experimental groups were better than those in control group. Students taught with Computer Assisted Concept Mapping Instructional Model (CACMIM) achieved and retained better than those taught with Computer Assisted Analogical Instructional Model (CAAIM). The result also showed that gender had no significant effect on achievement of students in Chemistry.Based on the findings of this study, it can be recommended that the use of computer assisted concept mapping instructional model and computer assisted analogical instructional model should be adopted as teaching strategies by science teachers in all secondary schools; government should organize and sponsor teachers to attend training courses on the use of CACMIM and CAAIM as instructional strategies as well as other computer assisted instructional models; teachers should study and harness appropriate and familiar analogy and concept mapping strategies in their lesson planning and teaching of science concepts.

Keywords: *Achievement, Analogical Instructional Model, Computer Assisted Instruction(CAI), Concept Mapping, Computer Assisted Concept Mapping, Computer Assisted Analogy.*

Introduction

Development of a nation at any phase is always linked with technology, and technology is a product of science. Basically, science is known as the study of knowledge, which is made into a system and depends on analyzing and understanding of facts while technology is the application of scientific knowledge (Pujari, 2015). For any nation to get developed, the application of both science and technology has to go hand in hand.

According to Seweje (2010), the basic focus of education is to serve as a veritable tool for preparing young generation to live a productive adult life in the contemporary society. The contemporary society is fast changing and one major factor of change is the combined influence of science and technology, particularly, Information and Communication Technology (ICT).

The product of science and technology has contributed significantly to the development of countries. Through the application of science, scientific knowledgeable professionals have been able to invent equipment and machines used in industries and homes. In addition to this, science and technology has helped in easing stress brought by movement of goods and people from one place to another, by inventing easy transportation equipment like automobiles, aircrafts among others. Furthermore, science and technology has helped in the area of medicine, communication, food production, electricity, good road, advertising, sports and lots more. It is incontrovertible to say that science and technology play important roles in the development of any nation.

Osisioma (2006), and Ahmed (2008) stated that science teachers still use the conventional method of teaching which has been found to impede students' performance. This method has not aided meaningful learning of science. Yildirim, Acar, Bull & Sevinc (2008) reported that other methods like simulation and game, laboratory, discovery and science puzzles to mention just a few have been tried but students' performance did not improve significantly.

Bennett & Ross (2011) reported that the use of technology in the classroom increases the retention of science concepts and gives a unique and entertaining classroom environment. They also reported that students retain information from individual work and incorporation of interest. Udogu & Njelita (2010) stated that the use of concept maps had a significant effect on students' achievement and retention in organic chemistry. There is therefore, the need to examine the present methods of teaching science with a view to evolving a suitable strategy with higher chances of leading to effective teaching and learning of science.

Seweje & Jegede (2009) summarized various methods which researchers globally have found to be effective in promoting students' achievement in science to include: concept mapping, analogy, metaphor, simile, Vee mapping, co-operative learning, schema activation, conceptual change model, problem solving and adapted role modelling and application of Computer Assisted Instruction (CAI). Among modern methods of teaching that are presently gaining attention worldwide are the use of concept mapping and analogy. These methods, according to Koroka & Ezenwa (2012) and Fatokun (2014), have been described to be effective in science teaching and learning.

In the Nigerian educational system, a systematic exposure to science seems to be the prerogative of the formal school

system. At the secondary school level, science is presented to students as specific science subjects. These include Basic Science, Physics, Chemistry, Biology, Mathematics and Agricultural Science. Chemistry is presumed to be the fulcrum upon which all other sciences and technology are attached. It serves as a pre-requisite for almost all science and technological programmes in the tertiary level of education (Jantur, 2005). The chemical science permeates all the branches of science, and makes use of chemical principles. Chemistry plays a crucial role in the industries by isolating, extracting, analyzing and synthesizing the natural resources. Industries like petrochemical, agricultural, medical, textile and many others rely on, and make use of the principles of chemistry (Onu, 2007). Due to the importance of Chemistry education to the industrial and economic development of any nation, Chemistry should be accorded a priority position among other sciences.

Concept maps are graphical tools for organizing and representing knowledge. They include concepts (usually enclosed in circles or boxes of some type) and relationships between concepts (indicated by a connecting line linking two concepts) (Novak &Canas, 2006). Concept mapping is regarded as a graphic representation that corresponds to perceived reality (Ezenwa, 2005). It is also referred to as a technique for representing the structure of information visually. In other words, concept mapping is an example of meta-cognitive strategy which aids organization of concepts, if used as an instructional strategy. Studies carried out by Novak & Canas (2008) and Novak & Alberto (2008) have all shown that concept mapping facilitates learning of science concepts, promotes meaningful learning and enhances achievement. According to Mintzes, Wandersee & Novak (2000), concept mapping is not only useful as a learning pattern but also as an effective instructional strategy for in identifying misconceptions held by science students about scientific concepts.

Analogy has been described as a pictorial or metaphorical method of thinking that suggests areas of similarities between two or more things that require observation or experimentation to be empirically established (Abdullai, 2014). Analogy has also been referred to as mapping of knowledge from one domain (the base) to another (the target). This implies that there exists similarities between the base and the target with functional differences. Analogy is also described as a process of identifying similarities between two concepts, the familiar concept (the analogue) and the unfamiliar concept (the target). (Glynn, 1999).

Many empirical studies have been conducted both in Nigeria and other countries on the use of analogy as an effective strategy and it has been found to be effective in improving students' performance (Wushishi, 2011). Lagoke (2000) used analogical linkage from the socio-cultural environment of the learners to determine the ability of analogy in enhancing the learning of certain science concepts. It was found that analogies from cultural environment of learners helped students to create vivid images of science concepts which led to a better understanding of the concepts, hence higher achievement and retention.

Students' academic achievement generally refers to students' achievement in an academic area. It refers to the academic subject areas a student studies in school and the skills the student is expected to master in each of the academic areas. There are high, average and low achievers (Rouse & Barrow, 2006).

The influence of gender on students' achievement in chemistry with the use of analogical model will be given consideration in this study. Gender is a cultural construct that distinguishes the roles, behaviour, mental and emotional characteristics between males and females as defined by a society (Uduosoro, 2011). Ekeh (2003) discovered that male secondary school students performed better than females in science and mathematics. On the other hand, Yusuf &Afolabi (2010) reported that gender has no significant influence on students' performance in science. Njoku (2009), in his study on enhancing the relevance of chemistry curriculum delivery using science, technology and society (STS), stated that female students underachieve in science, technology and mathematics education relative to their male counterparts. It is because of these divergent views that the researcher set out to consider the effect of gender on chemistry students' achievement when taught with Analogical Instructional Model.

The introduction of tablets, popularly known as 'OponImo',as an instructional aid to Senior Secondary School students in Osun State coupled with widespread use of cell phones, has aroused the interest of students in the use of computer as a means of information, communication and classroom instruction. The access to the tablets has also helped in demystifying computer and its usage. The present study incorporated the computer to sustain the interest of students in the use of computer as a means of instruction. Hence, this study investigated the effects of Analogical Instructional Models on Secondary School Students' Achievement in Chemistry. The researcher is of the opinion that students might find the use of the models interesting and fascinating in learning difficult concepts in Chemistry.

Statement of Problem

It appears that the instructional strategies used by Chemistry teachers is one of the major factors responsible for the students' poor performance as it has been observed that most Chemistry teachers adopt the conventional method of teaching which seemingly leads to poor achievement and retention of chemistry concepts.

Research Hypotheses

1. There is no significant difference in the achievement mean scores of students in CACMIM, CAAIM and conventional groups before treatment.
2. There is no significant effect of CACMIM and CAAIM on students' achievement mean scores in Chemistry
3. There is no significant difference in the achievement mean scores of male and female students exposed to CACMIM and their counterparts exposed to CAAIM.

Methodology

Sample and Sampling Technique

The sample for this study is 284 Senior Secondary School II chemistry students of intact classes selected from nine Senior Secondary Schools in Osun State through purposive sampling technique. Three schools were selected from each of the three senatorial districts in the state. The schools were randomly assigned to groups. Thus, there were three schools in each of the three groups; experimental group 1, experimental group 2 and control group.

Research Instrument

The research instrument used for the purpose of this study was Chemistry Achievement Test (CAT) which consisted

of 50 multiple choice test items on Chemical Equilibrium.

Instructional Models

The research materials used for this study were the Computer Assisted Concept Mapping Instructional Model (CACMIM) and Computer Assisted Analogical Instructional Model (CAAIM).

Experimental procedure

Pre-test was administered to the participants with the assistance of research assistants. The concept of Chemical Equilibrium was taught to experimental Group 1 and 2 using the CAI packages, CACMIM and CAAIM respectively while the control group was taught with the conventional method. Post – test was administered, students were grouped into achievement levels (high, average and low) based on their pre - test scores.

Data Analysis

The hypotheses were tested using Analysis of Variance (ANOVA), Analysis of Co-variance (ANCOVA) and Multiple Classification Analysis (MCA) to determine the effectiveness of the treatment on students' achievement and retention mean scores in Chemistry. All hypotheses were tested at 0.05 level of significance.

Results

Hypothesis 1: There is no significant difference in the achievement mean scores of students in CACMIM, CAAIM and Conventional groups before treatment.

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Table 1 : Summary of ANOVA showing achievement mean scores of students in CACMIM, CAAIM and Conventional groups before treatment.

Source	*SS*	*Df*	*MS*	F_{cal}	F_{table}	*P*
Between Groups	270.379	2	135.189	2.017	3.03	0.135
Within Groups	18836.495	281	67.034			
Total	19106.873	283				

Table 3 reveals that Fcal (2.017) is less than Ftable (3.03) at 0.05 level of significance. ($F_{2, 281}$= 2.017; p>0.05). The null hypothesis is not rejected. This implies that there is no significant difference in the achievement mean scores of students in CACMIM, CAAIM and Conventional groups before treatment. This implies that the three groups are homogeneous.

Hypothesis 2: There is no significant effect of CACMIM and CAAMIM on post test achievement mean scores of students in Chemistry.

Table 2: Multiple Classification Analysis (MCA) showing the achievement of students in the CACMIM, CAAIM and Conventional groups

Grand Mean=65.19					
Variable + Category	N	Unadjusted Devn'	Eta^2	Adjusted For Independent +Covariate	Beta
CACMIM	88	7.91	.88	6.90	.50
CAAIM	96	5.81		6.26	
Conventional	100	-12.53		-12.07	
Multiple R 0.502 Multiple R^2 0.252					

Table 2 reveals that students taught using Computer Assisted Concept Mapping Instructional Model had the highest adjusted mean score of 72.09 (65.19+6.90). This is closely followed by those taught with Computer Assisted Analogical Instructional Model with an adjusted mean score of 71.45 (65.19+6.26) while those exposed to conventional method had the least adjusted mean score of 53.12 (65.19+ (-12.07). The treatment accounted for about 88% (Eta^2=0.88) of the observed variance in students' achievement in Chemistry. Therefore CACMIM and CAAIM had significant effect on students' achievement in chemistry. CACMIM had greater effect on students' achievement in chemistry than CAAIM while the conventional method had the least effect.

Hypothesis 3: There is no significant difference in the achievement mean scores of male and female students exposed to CACMIM and their counterparts exposed to CAAIM.

Table 3: Summary of ANCOVA showing achievement mean scores of students in the CACMIM and CAAIM groups by gender

Source	*SS*	*Df*	*MS*	F_{cal}	F_{table}	*P*
Corrected Model	7042.862	4	1760.716	131.973	2.42	.000
Covariate (Pretest)	6741.272	1	6741.272	505.285	3.89	.000
Gender	1.629	1	1.629	.122	3.89	.727
Group	12.038	1	12.038	.902	3.89	.343
Gender * Group	3.062	1	3.062	.230	3.89	.632
Error	2388.132	179	13.342			
Corrected Total	9430.995	183				
Total	963431.000	184				

p>0.05

Table 3 shows that Fcal (0.230) is less than Ftable (3.89) at 0.05 level of significance. The null hypothesis is not rejected. This implies there is no significant difference in the achievement mean scores of male and female students exposed to Computer Assisted Concept Mapping Instructional Model and their counterparts exposed to Computer Assisted Analogical Instructional Model ($F_{1, 179}$=0.230; p>0.05). Similarly, the main effect of gender ($F_{1, 179}$=0.122, p>0.05), treatment ($F_{1,179}$=0.902, p>0.05) on the achievement mean scores of students in Chemistry is not significant at 0.05 level in each case.

Conclusion

From the findings of this study, it could be concluded that students' exposure to Computer Assisted Concept Mapping Instructional Model resulted in a remarkable increase in achievement and retention. This implies that the use of these models as instructional strategies is very effective and efficient in boosting students' achievement and retention.

Recommendations

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

1. The use of computer assisted concept mapping and computer assisted analogical instructional model as teaching strategies should be adopted by science teachers in all secondary schools.

2. Computer systems and other facilities that would ensure the effective use of the models should be provided in secondary schools, and students should be given access to them.

3. Government should organize and sponsor teachers to attend training courses on the use of CACMIM and CAAIM as instructional strategies specifically, and CAI in general.

4. Authors should use relevant concept maps and analogies in presenting concepts and principles in science textbooks

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ASSESSMENT OF SOIL FERTILITY STATUS IN COLLEGE OF EDUCATION ILESA FARM LAND OSUN STATE, SOUTH-WESTERN NIGERIA

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AUTHORS CONTRIBUTIONS

This work was carried out in collaboration between the two authors. Author OTO performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author AKF managed the analysis of the study and the literature searches. Both authors read and approved the final manuscript.

ABSTACT

Low soil fertility is recognized as an important constraint to increased food production and farm incomes in south western Nigeria. Therefore soil fertility management is a major issue in the African agricultural development debate. Hence this study assessed the soil fertility status in Osun state college of education farm land with a view to providing information for future land use planning and management. This study determines soil physico-chemical properties under different agricultural land managements system.

Basic data of interest include soil characteristics in terms of fertility status. Five different land management systems; cocoa, palm tree, cassava, maize, and forest were identified. A sampling plot of 10m by 10m was marked out from the middle of each farm. Primary data include soil samples, landsat imageries for three epochs were acquired for the land use dynamics of the study area. The Normalized Difference vegetation index (NDVI) was undertaken for the study in order to assess the health of the vegetation over years. Selected soil samples were subjected to laboratory analysis with soil pH particle size, total nitrogen, available phosphorus, exchangeable cations, exchangeable acidity, organic carbon and other micro nutrients were determined. All statistical analysis were carried out using SPSS version 16 where mean comparisons were carried out to determine the physical-chemical properties of soil under different land use types. One way analysis of variance ANOVA was employed to determine soil properties. The results showed that massive deforestation and conversion to crop production, continuous and intensive cultivation of soils with very low inputs have been practiced in the area over the past 4 decades. The result of the physical and chemical characteristics between 0-15cm and 15-30cm layer indicated that with the exception of pH Ap and Mn, the concentration of other variable exhibited significant differences across the land use types ($p<0.05$). The result of vegetation change detects using normalized difference vegetation index revealed that large percentage of the study area was covered by tick forest in 1986 but rarely disappearance of forest cover from the study area in 2015 (upper and lower bands of NDVI values drop by 0.363 and 0.666 respectively. The study conducted that intensive cultivation of land and massive deforestation in the college farm had resulted in deterioration and declined soil fertility in the area.

Keywords: Soil Fertility, College Farm, Physico-chemical and soil management

1. INTRODUCTION

The fertility of the soil is measured by the soils ability to supply the roots of growing plants with water, oxygen and nutrients in right proportion. The fertility of the soil is central to the sustainability of both natural and managed ecosystem because it is the medium from which terrestrial production emanates. Shagufta (2012) stated that fertile soil should have the following properties.

- It is rich in nutrients necessary for basic plant nutrition, including nitrogen, phosphorus and potassium.
- It contains sufficient minerals (trace elements) for plant nutrition, including boron, chlorine, cobalt, copper, iron manganese, magnesium, molybdenum, sulfur and zinc.
- It contains soil organic matter that improves soil structure and soil moisture retentions
- Soil pH is the range 6.0 to 6.8 for most plants but some prefer acid or alkaline condition.
- Good soil structure, creating well drained soil, but some soils are wetter or drier.
- A range of micro-organisms that support plant growth.
- It often contains large amount of top soil.

In natural ecosystems, soil minerals basically stay in place. Trees uptake minerals pass the minerals to the leaves and the leaves fall back to the earth where the process start all over again. Farmers remove the crops before the minerals can be replaced in the soil. There are ways to reduce the mineral loss, but there is no way to stop it from happening completely. In creating a sustainable agriculture, soil fertility maintenance is an important step.

Low soil fertility is recognize as an important constraint to increased food production and farm income in south-Nigeria. (Akinloye 2017). Inadequate soil moisture for plant growth aggravates the problem of soil fertility. The introduction and adoption of/ irrigation system/ technologies in some area has significantly reduced the constrain of soil moisture to crop production. The condition of soil physical properties such as water holding capacity, porosity and bulk density determine soil fertility status. Improvement of crumb structure and other physical properties are some important aspects of soil fertility status.

During cropping the soil is exposed to the direct impact of high intensity of rainfall which breaks down soil crumbs. When soil does not supply sufficient nutrients for normal plant development and optimum productivity, application of supplementary nutrient is required. Therefore the proper application rates of plant nutrients are determined about knowledge of the nutrient requirements of the cropping and the nutrient supplying power of the soil. This study therefore assess the soil fertility status in osun state college of education farm land.

2 MATERIALS AND METHODOLOGY

2.1 STUDY AREA.

The study was conducted in Osun state college of education farm land. The college was established in the year 1978 by the then Oyo State Government of Nigeria. The area is located between latitude 7'05N and 17'03N and between longitude 4'03E and 4'07E. The location has been identified as one of the major food baskets of Ijesa region and cash crops production for Nigeria natural economy. This areas covering about 2000 hectares has been dedicated for consistent arable and cash

crops production for over four(4) decades. The area falls within the tropical rainforest zone. The mean annual rainfall is about 130mm and mean annual temperature is about 27°c with the annual range of about 3°c. during the raining season, the relative humidity is hardly below 85%, whereas it may be as low as 65% during the dry season (Emielu,2003) the geology of the study area has been elaborately described by smith and Montgomery (1962). The area is underlain by gneiss and biolite achicst. These are typically fine-grained, strongly foliated rocks composed of a mosaic of plagioclase Feld spared quartz with abundant biotic Mila. The soil of Ijesa region belongs to the highly ferruginous tropical red soils associated with basement complex rocks. The soils are derived from the basement complex parent material and classified as aquic, tropaquepts typic and aeric typical tropaquets. Adesina (1991) stated that the lowland tropical rain forest is noted for being the most diverse, luxuriant and productive in terms of grass organic matter on earth, hence a reservoir of genetic materials unequalled elsewhere.

In the low land tropical rainforest, the crown of the trees tend to form three distinct layers the tallest layer grows upward towards the light and often attains a height of between 30 and 40 meters. The vast majority of the trees of this region are evergreen, simultaneously shedding their old leaves and growing new ones. The major occupation of people in Ilesa area is farming presently the primary vegetation of the area has been degraded by cultivation and population growth thus gives rise to the secondary forest now covering the area.

2.2 DATA COLLECTION AND ANALYSIS

Both primary and secondary data were collected and analyzed in other to achieve he objectives of the study. The basic data of interest in this study are soil characteristics. The land use types considered were soil under arable crops, tree crops and forest. Satellites imageries were acquired for three epochs for the study area and socio-economic data were collected through questionnaire administered to stake holders responsible for the use of soil and land management in the study area. Three different stapes were involved in the study. In the first stage, reconnaissance and a pilot survey were conducted across the college farm, thereafter, the sampling strategies/ procedures were designed and the required system of investigation were prepared. The second stage concerns the interview of the sampled farmers after which some farms visited and farmers were then made to identify the soil types. They mentioned in the field. Collection of soil samples and laboratory analysis followed. The third stage was the analysis stage where data collected and satellite imageries were analyzed, presented and discussed in the context of the objectives of the study. The final research report was then written for presentation and publication.

Five land covers were selected across the study area; cocoa, palm tree, cassava and maize and forest to serve as five different treatments. In each of the land covers, a piece of land measuring 10m by10m were mapped out from which ten sampling points were selected. Soils were taken at two depths, 0-15cm and 15-30cm to serve as top and sub soil samples respectively. This sampling scheme indicated that there were 40 from which 80 soil samples were collected from under cocoa, palm tree, maize cassava and forest (i.e 40 top soil and 40 sub soil) Sampling core was used to collect samples from bulk density. While soil auger was used to collect all other soil samples. The composite soil samples collected were packaged in a well labeled polythene bags for laboratory physical and

chemical analysis.

Soil pH was determined in a 1;1 soil to water suspension using ed 1;1 soil to MKI the Dwyer model WPH water proof pH tester, particle size distribution was determined using the hydrometer method (Bouyoucus, 1981). Total nitrogen was determined using macro-kjedahl method (Jackson, 1962). Determination of available phosphorus as determined by ascorbic acid molybate blue method as described by murphy and Riley (1962). Exchangeable cation (Ca^{2+},Mg^{2+},Na^{+} and K^{+})were extracted with 1m ammonium acetate, exchangeable acidity was determined using the Walkley and black method (1934). Available trace elements (Fe, Mn, Cu, and Zn) were extractd using DTPA method, 0.1 MHCl and two acid mixture (0.05M HCl and 0.0125M H_2SO_4)methods

RESULTS AND DISCUSSION

4.1 Concentration of Soil Physico-Chemical Properties under different land use types The concentrations of selected parameters in the study area are presented in Table 1. And 2 for top soil and subsoil layers respectively. The pH showed that the soils were generally slightly acidic at the different land use types, except maize at the 15-30cm soil depth. It is evident from Table 4.1 that soil under maize, are slightly more acidic (5.4-7.3) while the organic carbon content, total nitrogen, K, Mg and Zn concentration under the forest soil were more than those of other landuses (P< 0.05) at the 0-15cm soil depth. Soils under maize concentration contained more available P and Cu than the other landuses. The soils pH value was significantly affected by landuse (p<- 0.05) landuse changes for examole forest to cassava and maize resulted in reduction of soil pH of the study areas. Except in the case of tree crops that maintain the same level of pH value with forest land (Table 1). The lowest of alkaline nature of soils under the arable crops (maize and cassava) may be due to two major reasons the first is the depletion of basic cations in crop harvest. Secondly, it may be due to its highest microbial oxidation that produces organic acids to the soil solution and thereby lowers soil pH. Generally the pH values in the study area are within the ranges of neutral and slightly alkaline soil reactions. The acidity nature of soil could be due to the acidic nature of parent material and somehow extensive weathering of soil and leaching (Ekanade,1988). Soils under maize concentration contained more available P and Cu than the other land uses, whereas the value of exchangeable acidity, Na and Mn were more under palm tree concentration. Cocoa farm has more Ca than other sites (Figure 4.1).

In terms of the subsoil (15-30cm) layer, soil under maize was basic (average of 9.6 unit) whereas mean pH at the other sites indicate slight acidity to neutral. Unlike the 0-15cm layer, only organic carbon occurred at 9 comparatively higher concentration in the forest site. Palm tree site exhibited higher concentrations of total nitrogen, exchangeable acidity, Ca, K, Mg, Na and Zn whereas the site under maize cultivation contained higher value of available P, Mn, Fe, and Cu has the other site (table 4.2). Organic carbon was higher at the cocoa site than other sites.

In general most variables exhibited significant differences between the forest and other landuses at the 0-15cm and 15-30cm layer indicate that significant difference occurred more between cocoa, and palm trees (OC, TN, EA, Ca, K, Na, Cu and Zn) and between palm tree and cassava

and forest among others. There is however no significant variation with pH. AP and Mg among the landuses (Table 3).

Table .1: Values of selected physico-chemical parameters at different landuse types (topsoil)

	COCOA	PALM TREE	MAISE	CASSAVA	FOREST
pH	6.9 ± 0.3a	6.8 ± 0.4ab	6.4 ± 0.4c	6.3 ± 0.2c	6.7 ± 0.2b
		(6.2 – 7.4)	(5.4 – 7.3)	(6.0 – 6.6)	(6.3 – 6.9)
OC/	26.7 ± 6.5b	19.8 ± 9.3c	18.9 ± 7.6c	21.0 ± 13.5bc	35.8 ± 13.0a
(mg)	(3.2 – 34.8)	(6.5 – 43.5)	(7.1 – 35.7)	(5.8 – 57.4)	(20.8 – 59.4)
TN	2.5 ± 0.4b	2.0 ± 1.0b,c	1.8 ± 0.8c	1.9 ± 1.0b	3.7 ± 1.3a
c-	(1.7 – 3.1)	(0.6 – 4.5)	(1.1 – 3.7)	(0.6 – 3.9)	(2.1 – 6.1)
AP	6.5 ± 4.0a	15.6 ± 17.0a	20.9 ± 15.7a	16.9 ± 33.4a	4.0 ± 3.0b
	(1.1 – 20.1)	(1.0 – 50.6)	(5.0 – 60.0)	(0.5 – 135.2)	(1.0 – 12.3)
EA	0.2 ± 0.0c,b	0.7 ± 0.5a	0.4 ± 0.3b	0.2 ± 0.1b	0.3 ± 0.1c
	(0.2 – 0.3)	(0.2 – 2.2)	(0.2 – 1.4)	(0.1 – 0.3)	(0.2 – 0.5)
Ca	11.2 ± 12.3a	7.5 ± 5.5a,b	11.0 ± 3.1a	8.5 ± 6.1a,b	3.7 ± 4.0b
	(1.2 – 60.7)	(1.1 – 19.6)	(4.9 – 18.2)	(4.2 – 29.6)	(1.8 – 20.3)
K	0.2 ± 0.1b	0.5 ± 0.1b	0.2 ± 0.1b	0.3 ± 0.1b	32.9 ± 30.7a
	(0.1 – 0.8)	(0.3 – 0.8)	(0.1 – 0.6)	(0.1 – 0.3)	(0.3 – 81.3)
Mg	1.0 ± 0.5b	0.4 ± 0.2c	0.3 ± 0.1c	0.3 ± 0.1c	1.5 ± 1.0a
	(0.1 – 1.6)	(2.3 – 0.8)	(0.1 – 0.7)	(0.2 – 0.5)	(0.4 – 4.1)
Na	0.5 ± 0.1b	2.5 ± 0.1a	0.6 ± 0.1b	0.6 ± 0.1b	0.3 ± 0.1c
	(0.1 – 0.6)	(2.2 – 2.8)	(0.5 – 0.8)	(0.5 – 0.9)	(0.3 – 0.3)
Mn	163.8 ± 32.2a	172.8 ± 148.5a	157.4 ±84.7a	109.7 ± 71.9a	96.0 ± 46.7b
	(110.9 – 220.5)	(46 – 74.6)	(53.8 – 294)	(8.9 – 232)	(51.6 –246.5)
Fe	106.9 ± 176.0a	62.6 ± 9.4a	98.5 ±104.2a	62.9 ± 28.9a	36.4 ± 10.1b
	(20.4 – 843)	(43.3 – 76.3)	(22.6 – 32.9)	(15.2 –110.9)	(26.5 – 63.6)
Cu	1.0 ± 0.4c	2.6 ± 0.8b	4.9 ± 1.9a	1.0 ± 0.6c	2.5 ± 1.0b
	(0.5 – 2.1)	(1.2 – 4.6)	(1.6 – 8.5)	(0.1 – 2.2)	(1.5 – 6.0)
Zn	1.0 ± 0.2b	1.2 ± 0.6b	1.0 ± 0.1b	1.0 ± 0.2b	3.8 ± 2.7a
	(0.6 – 1.4)	(0.7 – 1.5)	(0.8 – 1.4)	(0.6 – 1.4)	(1.5 – 11.1)

N.B: Interaction means within a specific soil parameter followed by the same letter(s) are not significantly different from each other at $P \leq 0.05$,

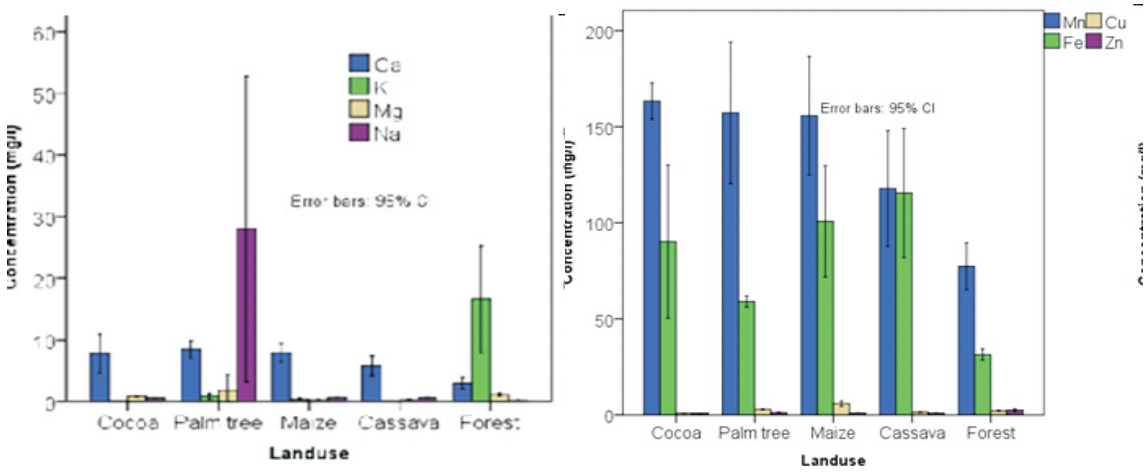
Table .2: Values of selected physico-chemical parameters at different landuse types (subsoil)

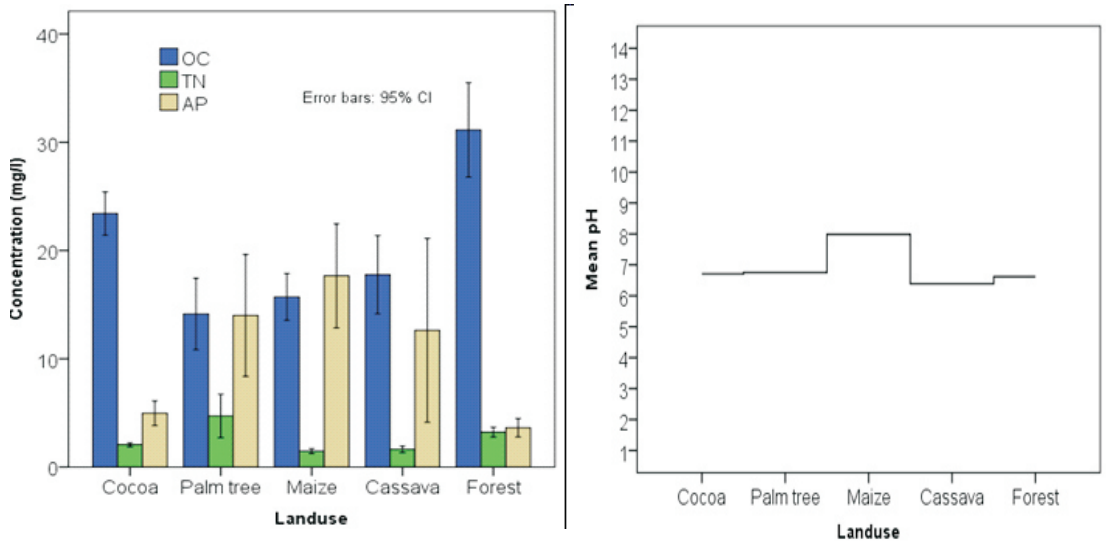
	COCOA	**PALM TREE**	**MAISE**	**CASSAVA**	**FOREST**
pH	6.5 ± 0.4a	6.8 ± 0.45a	9.6 ± 13.7a	6.5 ± 0.4a	6.6 ± 0.2a
	(6.1 – 7.6)	(6.0 – 7.8)	(6.0 – 67.7)	(6.0 – 7.4)	(6.0 – 7.0)
OC	20.1 ± 3.8b	8.5 U 8.1d	2.6 ± 4.0)d	14.5 ± 7.5c	26.5 ± 13.0a
	(12.1 – 27.1)	(0.3 – 25.2)	(4.6 – 19.7)	(4.9 – 34.2)	(7.3 – 50.7)
TN	1.6 ± 0.4b	7.4 ± 8.0a	1.1 ± 0.4b	1.3 ± 0.8b	2.7 ± 1.3b
	(1.8 – 3.1)	(0.9 – 27.7)	(0.7 – 51.5)	(0.4 – 3.3)	(0.8 – 5.2)
AP	3.4 ± 2.3a	12.4 ± 18.5a	14.4 ± 14.0a	8.3 ± 17.0a	3.2 ± 2.20a
	(0.1 – 7.5)	(1.8 – 81.8)	(0.7 – 51.4)	(0.3 – 69.5)	(0.1 – 7.4)
EA	0.2 ± 0.1b	0.4 ± 0.2a	0.2 ± 0.1b	0.2 ± 0.1b	0.2 ± 0.1b
	(0.2 – 0.3)	(0.2 – 0.9)	(0.1 – 0.3)	(0.1 – 0.2)	(0.1 – 0.4)
Ca	4.3 ± 3.6b	9.4 ± 3.2a	4.8 ± 3.6b	3.1 ± 1.7b	2.3 ± 0.3b
	(1.1 – 13.7)	(2.8 – 15.9)	(1.1 – 12.6)	(0.9 – 7.9)	(1.8 – 2.9)
K	0.1 ± 0.1d	1.2 ± 2.0c	0.5 ± 0.8a	0.1 ± 0.1c	0.3 ± 0.1b
	(0.1 – 0.2)	(0.1 – 7.5)	(0.2 – 3.8)	(0.1 – 0.3)	(0.1 – 0.7)
Mg	0.7 ± 0.2a	3.1 ± 11.7a	0.3 ± 0.1a	0.3 ± 0.1a	0.7 ± 0.2a
	(0.3 – 1.1)	0.3 – 5.3	(0.1 – 0.5)	(0.2 – 0.5)	(0.4 – 1.0)
Na	0.6 ± 0.1b	53.6 ± 105.0a	0.7 ± 0.1b	0.6 ± 0.1b	0.3 ± 0.1b
	(0.5 – 0.7)	(2.2 – 26.2)	(0.5 – 0.8)	(0.3 – 0.8)	(0.2 – 0.3)
Mn	103.0 ± 27.7a	141.7 ± 148.5a	154.1 ± 109.2a	16.0 ± 113.7c	58.8 ± 9.2b
	(120.8 – 220.5)	(5.6 – 2.8)	(6.3 – 39.3)	(11.5 – 3.7)	(40.6 – 86.5)
Fe	73.5 ± 17.7b	55.4 ± 7.1b	103.0 ± 77.2b	168. ± 126.6a	36.5 ± 3.9c
	(39.1 – 108.7)	(38.6 – 6.5)	(43.6 – 3.4)	(77.1 – 4.5)	(20.1 – 34.3)
Cu	0.8 ± 0.4b	3.1 ± 1.2b	6.9 ± 5.7a	1.9 ± 0.8b	1.9 ± 0.4b
	(0.1 – 1.9)	(1.5 – 5.5)	(0.5 – 17.3)	(0.4 – 3.6)	(1.2 – 2.6)
Zn	1.0 ± 0.2a	1.3 ± 0.2a,b	1.1 ± 0.2a	1.1 ± 0.3a	1.2 ± 0.4a,b
	(0.6 – 1.4)	(1.0 – 1.9)	(0.8 – 1.4)	(0.7 – 1.9)	(0.4 – 1.9)

N.B: *Interaction means within a specific soil parameter followed by the same latter(s) are not significantly different from each other at P≤0.05,*

Table .3: Comparison of 0-15cm and 15-30cm

Variables	Cocoa		Maize		Cassava		Palm Tree		Forest	
	F-value	F-value	P-value	F-value	P-value	F-value	P-value	F-value	P-value	F-value
pH	10.6	0.00	1.00	0.31	3.2	0.08	0.01	0.97	1.50	0.23
OC	15.5	0.00	10.50	0.00	3.52	0.07	16.64	0.00	5.16	0.03
TN	51.4	0.00	12.10	0.00	4.25	0.04	9.01	0.01	5.14	0.03
AP	9.3	0.00	1.80	0.17	1.06	0.30	0.31	0.57	0.99	0.32
EA	3.0	0.09	10.3	0.00	0.11	0.74	5.19	0.02	6.26	0.02
Ca	5.3	0.26	35.5	0.00	15.01	0.00	1.73	0.19	2.35	0.13
K	15.6	0.00	2.40	1.29	15.2	0.00	2.34	1.34	22.5	0.00
Mg	5.8	0.02	1.16	0.28	4.58	0.03	1.09	0.30	12.65	0.01
Na	22.9	0.00	2.90	0.95	2.78	0.10	4.73	0.36	18.79	0.00
Mn	0.01	0.94	0.10	0.91	0.29	0.59	0.72	0.40	12.25	0.01
Fe	0.71	0.40	0.24	0.87	13.10	0.00	7.47	0.01	16.84	0.01
Cu	2.50	0.12	2.20	0.14	15.27	0.00	3.04	0.89	6.88	0.01
Zn	0.10	0.75	3.49	0.07	2.01	0.16	3.51	0.69	18.49	0.00





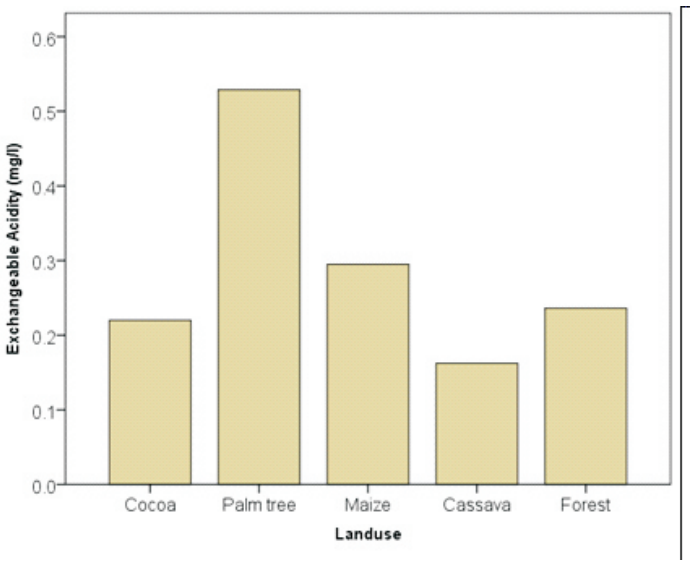


Figure .1: Concentration of investigated soil variables at different land uses

Variation occurred in the concentration of most of the investigated variables along the cocoa, palm tree, maize, cassava and forest landuses that were selected for this study (Table .1). Figure .1 shows that Na occurred at higher concentration 29mg/L among the investigated cations (K, Mg, and Ca) at the palm tree farms. Whereas K dominated the cassava and the forest farms. Ca^{+} occurred in higher concentration than the other cations at the cocoa farm. In addition Mn occurred in relatively higher concentration (mg/L) than fe, Zn and Cu at all the land use. In terms of the nutrients, the forest and cocoa soils were richer in OC than the other landuses, although the concentrations of the OC were higher than those of AP and TN at most landuse types, except the maize farm where AP is richer. The mean pH varied between 6 and 8, indicating variation between neutral and slightly alkaline soil nature of the landuses; soils under the maize cultivation were slightly more alkaline than the others. The concentration of EA however indicates higher acidity at the palm tree farms.

The results of the soils physicochemical characteristics between 0 – 15cm and 15 – 30cm layers indicated that with the exception of pH, AP and Mg, the concentration of other variables exhibits significant differences across the landuse types of 15 – 30cm soil layer ($P \leq 0.05$). The soil elements were significantly different between 0 – 15cm with all the investigated variables (Table .1 and .2). A comparison of the variable at the 0 – 15cm and 15 – 30cm layers indicate that significant difference occurred more between cocoa and palm trees (OC, TN, EA, Ca, K, Na, Cu and Zn) and between palm tree and cassava and forest among others (Table .3). There is however no significant variation with pH, AP and Mg among the landuses.

4.3 Response of soil Chemical Properties to Landuse Types

The soils pH value was significantly affected by landuse ($P \leq 0.05$) landuse changes for example forest to cassava and maize resulted in reduction of soil pH of the study areas. Except in the case of tree crops that maintain the same level of pH value with forest land (Table 1). The lowest of alkaline nature of soils under the arable crops (maize and cassava) may be due to two major reasons the first is the

depletion of basic cations in crop harvest. Secondly, it may be due to its highest microbial oxidation that produces organic acids to the soil solution and thereby lowers soil pH. Generally the pH values in the study area are within the ranges of neutral and slightly alkaline soil reactions.

Soil organic carbon was significantly affected at $P \leq 0.05$ by land use. It is evident from table 4.3 that palm tree and maize are not significantly different from each other while cocoa and forest are significantly different from other land use while, soil organic carbon content was highest (35.8 ± 13.0) under forest and lowest under maize (18.0 ± 7.6). The decline in soil organic carbon content in under arable and tree crop land use may be due to insufficient inputs of organic substrate from the farming system due to residue removal and zero crop rotation. Gebeyaw (2007) are credence to this findings. Besides leaching problem that can be attributed to the relatively high sand content in Table 4.1 and the resultant light texture of soils might be the cause of organic carbon reduction. Saggar et al (1996) that clay particles unlike the sand particles have substantial exchange surface areas and therefore absorb and stabilize organic carbon and soil nutrients ranged from 0.3 to 1.3. 0.3 under forest, 0.4 under cocoa, 1.2 under cassava, 1.3 under palm tree and 1.5 under maize. Using Landon (1991) classification soils under maize, cassava and palm tree had medium available phosphorous while the remaining land use type had low phosphorous contents. The low phosphorous content in most of the soil studied could be due to the low pH values in many of the soils in the study. According to Tisdale et al (1993) phosphorous availability is low in acid soils as well as in calcacerous soils. In most cases pH of 6.7 is optimum for adequate phosphorous availability. The results of available phosphorous composition in top and subsoil of the farm settlements show that sharp variation were seen in all the farm settlements under investigation.

In terms of exchangeable acidity, figure 4.1 show that it ranges from 0.18 – 0.6. it is evidents from the study that it is 0.18 mg/kg under cassava, 0.22 under cocoa 0.2 in forest, 0.3 in maize and palm tree. The highest in 0.6. Landon (1991) indicated in a study carried out that <0.4mg/kg is considered as low and >1.0mg/kg as high. This implies that soil under cassava maize, palm tree and cocoa had high content of calcium while that of forest had low calcium content. The low calcium content under forest may be due to the low pH values. This are credence to Chapman (1973) that soil with pH value of 5.0 or lower are likely to be deficient in calcium.

Figure 4.1 shown the data for exchangeable magnesium which ranged 0.1-0.5 mg/kg. Base on Landon(1991) findings, soils having <0.5 mg/kg are magnesium deficient

4.4 Micro Nutrient Contents

Figure 4.2 shown that the value of the DTPA-Mn level under the areas studied ranged from 80 to 170 mg/kg. Tisdale et al (1993) in their study categorized the value of Mn as low (0-50), medium (60-100) and high (>100). Based on Tisdale et al (1993) categorization, all soils observed in the study area have DTPA Mn content higher than the critical limit. According to Alloways and Ayres (1990) this could be due to low pH that favours the dissolution of Mn minerals

i4.1.13 Vegetation Pattern in the study Area between 1986 and 2015

Three optical datasets comprising Landsat OLI (2015), Landsat ETM+ (2000) and Landsat TM (1986) were utilized for the computation of NDVI for three epochs (1986, 2000 and 2015). Figure 1 present the 1986 NDVI map of the study area. The index values ranged from -0.333 to 0.536 with greater extent of the study area having positive index values. The computed range of NDVI values for 1986 revealed that larger percentage of the study area was covered by thick vegetation with evident slightly disturbed vegetation around built up areas across the study area.

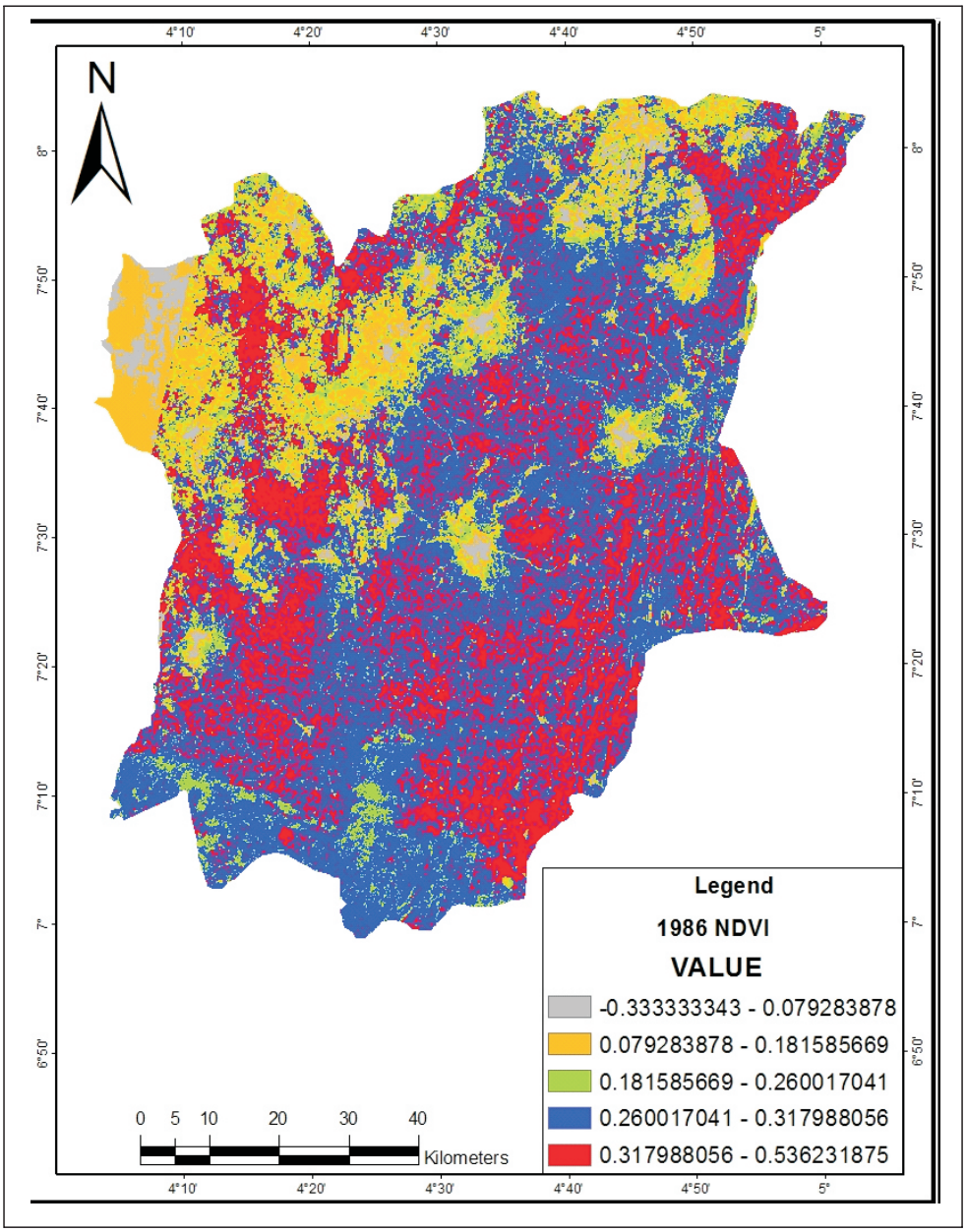


Figure 4.3: 1986 NDVI Map

The NDVI map for year 2000 is presented in Figure 2. The index values ranged from -0.428 to 0.197, indicating heavily disturbed vegetation across the entire study area. The observed reduced density and vigor of vegetation could be attributed to the prevalence of unsustainable natural resource exploitation that was taken to the limit between late 1990s and early 2000s.

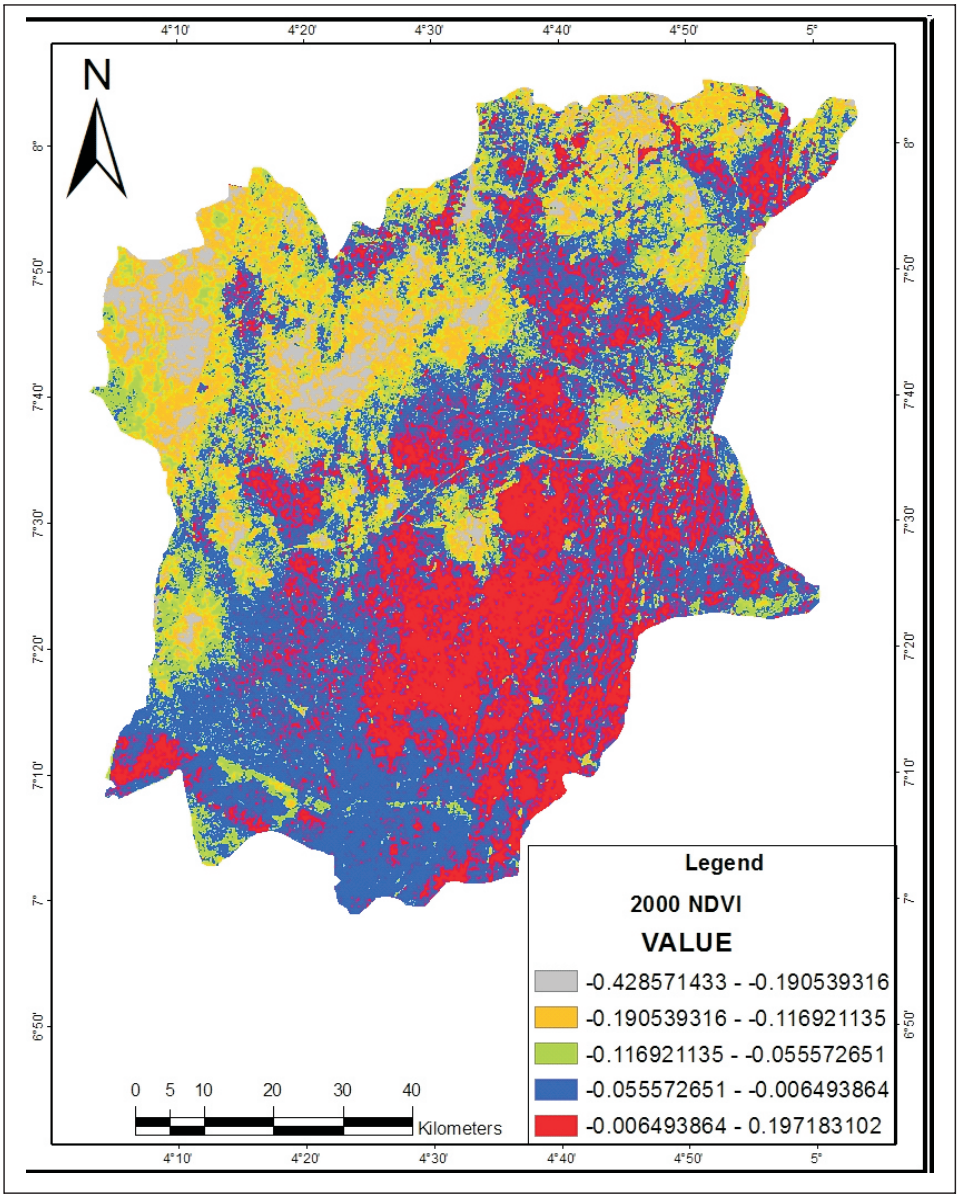


Figure 4.4: 2000 NDVI Map

The most devastated anthropogenic activity linking to the present state of deforestation is lumbering, which does not have respect for the reserved areas across the state and the college farm land not exclusive. Another poignant destructive activity in the state is the dry season bush burning, which has resulted to the destruction of very many forest reserves in Nigeria. Likewise, the prevalence of unsustainable agricultural system being practiced in the study area has resulted to massive deforestation as many virgin lands have been opened up for both commercial and subsistence agriculture. Figure 3 present the NDVI map for the year 2015. The index values ranged from -0.999 to 0.173, indicating near disappearance of forest cover from the study area.

Table 1 present the summary of the NDVI values of the study area in 1986, 2000 and 2005. Analysis revealed that the upper and the lower bands of NDVI values dropped by 0.339 and 0.095 respectively. Between 2000 and 2015 the upper and lower bands of NDVI values dropped by 0.024 and 0.572 respectively. Also between 1986 and 2015, it was observed that the upper and the lower bands of NDVI values dropped by 0.363 and 0.666 respectively. The interpretation of this statistics is that much of the impact was on the upper canopy layer (representing matured trees that are suitable for lumbering) of forest cover between 1986 and 2000 while impact was much on the lower canopy layer between 2000 and 2015. Also, it was observed that between 1986 and 2015, deforestation was much of reduction in density of flora than their vigor. However, result showed that the vegetation of the study area have been massively depleted both in terms of density and vigor between 1986 and 2015.

Year	Upper Band	Lower Band
1986	0.536	-0.333
2000	0.197	-0.428
2015	0.173	0.999

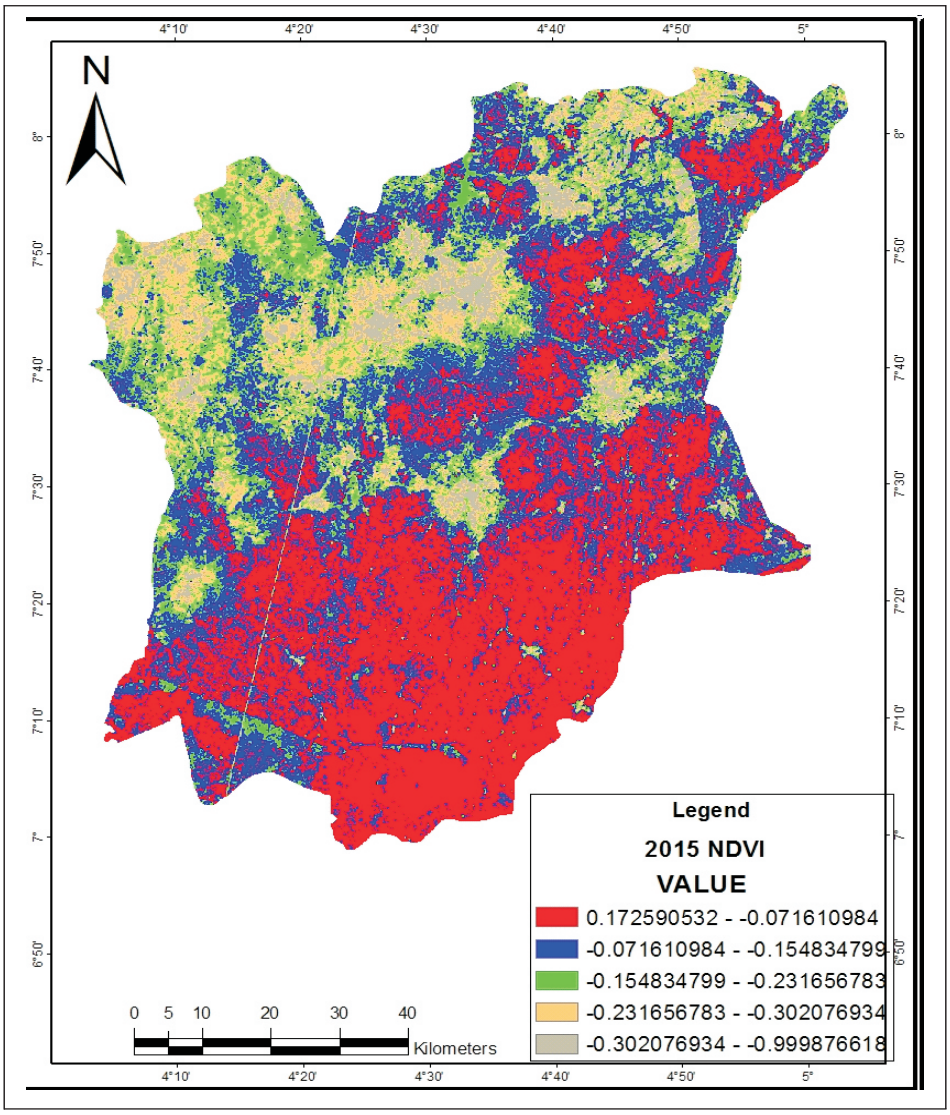


Figure 4.5: 2015 NDVI Map

CONCLUSION

The study clearly indicates that the soil physicochemical properties are significantly different among the various agricultural land use types. Vegetation characteristics under different land management systems in the area are significantly different. The picture that emerges from the totality of the findings is that intensive cultivation of land in the area has resulted to soil deterioration and decline of soil fertility status in the area. There is the need to establish

'land management informative career" for proper information on land management practices to farmer in other to help the in the aspect of soil management while formation of land use organizations should be encouraged to create harmonious atmosphere for interaction and exchange of ideas among one farmers.

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Dr. Fredrick A. Isife,
Chairman/Editor in Chief,
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SUBMISSION GUIDELINES FOR AUTHORS

Aim/Objective:

Federal Polytechnic Ado-Ekiti Journal of Science and Agricultural Technology (FEDPOLADJSAT) is a peer review international and bi-annual (April and October) publication of the Federal Polytechnic, Ado-Ekiti, Ekiti State, Nigeria. Itis a publication ofSEEM Research and Development Unit of the Federal Polytechnic, Ado-Ekiti, Nigeria. It aimed at publishing high-quality articles dedicated to all aspects of sciences and agricultural studies such as Archaeology, Entomology, Anthropology, Botany, Ecology, Zoology, Geophysics, Geology, Biology, Biochemistry, Chemistry, Microbiology, Brewing, Mathematics and Statistics, Artificial intelligence, Aquaculture and fisheries management, Computer science, Computer engineering and electronics, Telecommunications technology, Library and information sciences, Laboratory technology, Optometry, Surveying and geoinformatics, Architecture, Agricultural extension and communication technology, Agriculturalextension and rural development, Agricultural extension and rural sociology, Agriculturalextension services, Cooperative management, Agricultural-economics and extension, Agricultural management and extension, Agricultural administration and extension, etc. The journal hereby considers only manuscripts that have not been published (or submitted simultaneously) in any language elsewhere. Contributions are in English Language. Articles for publication may be theoretical, experimental, developmental, practical or specific case findings. Copyright is by the publisher. The journal is issued in printed form as bi-annual (April and October) volumes, and it currently accepts 3 types of articles defined as follows:

(i) Research Articles: this is a regular article which aims at presenting new findings.
(ii) Review Articles: this is an article which aims to present comprehensively already existing findings.
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Title Page:
The title page contains the title of the paper which should not be more than 12 words, name(s) and address(es) of the author(s), e-mail address(es) and telephone number. For double or multiple authors, the name of the correspondence author should precede that of others. The surname of the author(s) should be followed by the initials.

Abstract:
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Keji, S. A., Adeleke, O. & Oguntuase, A. (2019). External debt and economic growth in Nigeria. Journal of African Union Studies, 8(3), 161-177.doi:https://doi.org/10.31920/2050-4306/2019/8

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Momoh, J. J. (2013). Basic sociological concepts, attitude, perception and effects on propagating the message of HIV and AIDS prevention and control on engineering student of some selected tertiary institutions in Ekiti State, Nigeria, Journal of AIDS and HIV Research, 5(12), 443-447, Retrieved July 3, 2018, from - http://www.academicjournals.org/article/article1 384430372_Momoh.pdf

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Otalu, J. A. (2010). Nigeria today and the year 2020. ECPER Journal of Political and Economic Studies, 2(1), 8 -12.

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Surname, Initials. (Year of Publication). Title (edition – 3rd Ed.). Place of publication: Publisher, e.g.

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