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# **EDITORIAL**

It is my great pleasure to present to our dear contributors and readers, the Vol. 2 Number 1 of the FULafia Journal of Science and Technology (**FJST**). The late production of the current issue was affected by some logistic problems and we apologise to our contributors and numerous readers. We assure all our stakeholders that we will continue to work towards achieving the goals of the Journal. To this end, we are committed to sustain the timely production of the biannual issues of the Journal.

The Editorial Board has been reconstituted to strengthen the quality of the Editorial process with members now drawn from different Institutions within and outside Nigeria.

One of the recent achievements of the FJST was the successful acquisition of a website for the Journal. Contributors can now submit their articles online through the Manuscript Submission Form on the website. The Journal's website is http://www.fulafiajst.com.

A total of nineteen (19) research contributions on contemporary issues from researchers cutting across different Institutions in Nigeria working on different areas of the sciences and engineering are covered in the current issue.

We appreciate the support and encouragement of the Management of our great University under the able leadership of Prof. Muhammad Sanusi Liman to the Editorial Board. We also want to thank the Tertiary Education Trust Fund for financial support to the Publication.

We encourage contributors to visit our website and further enquiries can be directed to the editor through our website or through the Journal's email.

**Prof.E.H. Kwon-Ndung** *Chief Editor* 

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AGRICULTURAL AND BIOLOGICAL SCIENCES

# BACTERIOLOGICAL QUALITY OF SOME FERMENTED FOOD PRODUCTS IN KEFFI, NASARAWA STATE.

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# ABSTRACT

Garri, cassava and yam flours are African traditional fermented food products prepared from cassava and yam that is widely accepted by both rural and urban dwelling peoples with little concern about those microorganisms that are associated with it. The present study was undertaken to investigate the bacteria that are associated with these food flours. Total bacterial count ( $\times 10^5$  cfu/g) was found to be highest in cassava (7.1), followed by garri (6.2) and yam (4.4). The total coliform count ( $\times 10^5$  cfu/g) recorded 3.7 in cassava, 1.6 in garri, and 1.4 in yam flours. Similarly, total faecal coliform ( $\times 10^5$  cfu/g) was highest in cassava flour (4.1), while garri had 2.4, and yam recorded 2.2; also, the Staphylococcus aureus count ( $\times 10^5$  cfu/g) was highest in cassava flour (3.6), followed by yam flour (3.1), and garri flour had 2.8. However, the *Salmonella/Shigella* count ( $\times 10^5$  cfu/g) was high in garri flour (3.2), compared to cassava flour (2.5), and yam flour (1.2). The percentage occurrence of the bacteria isolates showed that Staphylococcus aureus was 86.7%, followed by Klebsiella spp. (60.0%), Proteus vulgaris (66.7%), E. coli (86.7%). Similarly, percentage occurrence of Salmonella spp. was 80.0% and Bacillus spp. 66.7%. The bacteria isolated were Staphylococcus aureus, Klebsiella spp., Proteus vulgaris, Salmonella spp., E. coli and Bacillus spp. The isolates were further subjected to antibacterial susceptibility tests using Kirby-Bauer disc diffusion method. The antibiotic susceptibility test revealed that most of the bacterial isolates were resistant to Nitrofurantoin (28%), Septrin (36%), Ampicillin (39%), slightly resistant to Perfloxacin (46%), Nalidixic acid (45%), Tetracycline (46%), slightly susceptible to Augmentin (63%), Ciprofloxacin (67%), Ofloxacin (52%) and highly susceptible to Gentamicin (95%). This present work revealed high bioload and vast array of bacteria in market garri, cassava and yam flours. It is therefore recommended that these food flours be sold in well packaged bags and not as exposed in basins/ bowls. Also, personal hygiene of hawkers and sanitation of utensils are important. Hawkers should be enlightened on hygienic practices.

Keywords: Bacteriological, quality, garri, cassava, yam flour, Keffi

# **INTRODUCTION**

Yam (*Discorea spp*) and Cassava (*Manihot esculenta*) are the most important root/tuber crops in Africa (Babajide *et al.*, 2006; Somorin *et al.*, 2011), and a significant source of calories for more than 500 million people worldwide (FAO, 2008). It is the most important crop in Nigeria in terms of food security, employment creation and income generation for cropproducing household (Ugwu and Ukpabi, 2002).

Nigeria is the largest producer of cassava in the world (FAO, 2008) with about 45 million metric tons and its cassava transformation is the most advanced in Africa (Egesi *et al.*, 2006; Adebayo-Oyetoro *et al.*, 2013). Cassava is grown throughout the tropic and could be regarded as the most important root crop in terms of area cultivated and total production (Ano, 2003; Adebayo-Oyetoro *et al.*, 2013). It is a major food in Nigeria (Ogbe *et al.*, 2007), essentially a carbohydrate food with low protein and fat (Adebayo-Oyetoro *et al.*, 2013). The major uses of cassava in Nigeria include flour, garri, fufu, livestock feed, confectionaries, monosodium glutamate processing, sweeteners, glues, textiles and pharmaceuticals (Oyeyiola *et al.*, 2014).

There are over 150 species of yam grown throughout the world. Yam contributes economically to more than 150 million people in West Africa and serves as an important source of income to the people. As of date, the age-old traditional method is still being used for the processing of yam to dried yam (Babajide *et al.*, 2006). The quality of the dried yams varies from one processor to another processor and location to location (Akissoe *et al.*, 2001). Yam can be consumed after direct cooking or fermented to produce flour which is used to prepare a dish locally called Amala (Oyeyiola *et al.*, 2014).

Gari is a granulated and dehydrated, cassava product. It is classified/ grouped based on texture, length of fermentation, region or place where it is produced and colour imparted by the addition/nonaddition of palm oil. It has a high swelling capability and can absorb up to four times its volume in water (Olopade *et al.*, 2014; Jekayinfa and Olajide, 2007).

Deterioration of flour products of yam and cassava are usually attributed to the types of packaging materials and pathogens such as bacteria and fungi (Okigbo, 2003). Flour foods can be infected by bacteria such as *Bacillus* spp, *Pseudomonas* spp, *Proteus* spp, *Klebsilla* spp and *Staphylococcus aureus* (WHO, 2001; Ogiehor and Ikenebomeh, 2006; Ijabadeniyi, 2007) some of these bacteria are pathogenic organisms which can cause certain disease if ingested beyond level of body tolerance. Also, there may be economic losses and food borne illness as a result of contamination by the bacteria.

Due to variation in different methods of processing of yam and cassava into flour for consumption, the need for bacteriological assessment of these products becomes very necessary in order to ensure safety of the product for consumption.

The most economic method of processing of yam and cassava tuber is by drying. The traditional drying process is carried out by the local women who normally target the period of scarcity as the purpose for preservation. However, the drying is carried out under unhygienic environment resulting in products of low hygienic quality. In most parts of the country, drying by the road side is most economical and this method however exposes the product to dusts, insects, animals and other environmental hazards (Ogori and Gana, 2013).

Microbial contamination of this processed yam or cassava is attributed to the method of processing as well as packaging materials. Some of these contaminants are pathogens which causes foodborne illness as well as economic loss to farmers. Understanding the bacteriological quality of these products which are commonly sold in road side becomes necessary in order to ensure their safety for human consumption. The aim of the study is to assess the bacteriological quality of garri, cassava flour and yam tuber flour sold in Keffi Metropolis.

# MATERIALS AND METHODS

This work was carried out within Keffi Metropolis of Nasarawa State which is located in the middle-belt of Nigeria. It is geographically situated on the latitude 8°50'N and longitude 7°52'E. Keffi town is about 850m above the sea level and it is the North-West of Lafia, the state capital. It is 53km away from Abuja (Capital of Nigeria) in the Guinea Savannah region of Nigeria (Obiekezie *et al.*, 2012; Akwa *et al.*, 2007).

A total of fifteen (15) samples were collected aseptically in a sterile polythene bag among local sellers in Keffi Main Market and transported immediately to the Microbiology Laboratory of Nasarawa State University, Keffi for analyses.The samples were prepared using the method described by Orji *et al.*, (2014) and Thoha *et al.*, (2012) with slight modification. 1g of each sample was added to 9ml of 0.1% (w/v) peptone water and homogenized by rolling between the palms at medium speed. Serial dilution into 5 fold was prepared by transfer of one millimeter of initial suspension into a tube containing 9ml of 0.1% (w/v) peptone water. These operations were repeated using a new sterile pipette to obtain  $10^5$ dilutions.

The bacterial load of garri, cassava and yam flourswere carried out by a method described by Adebayo-Oyetoro *et al.*, (2013). Briefly, samples of *FULafia Journal of Science & Technology Vol. 2 No.1 March*, 2016 garri, cassava flour and yam flour was serially diluted ten fold in which one gram (1g) of each sample was diluted in 9ml sterile distilled water followed by homogenization by horizontal and vertical agitation for a few minutes to obtain 10-1 dilution. Further 10fold dilution was made up to  $10^{-5}$  for colony count. 0.1ml of volume of each dilution were spread with sterile syringe on Salmonella/Shigella Agar, Mannitol Salt Agar, MacConkey Agar, Eosine Methylene Blue Agar and Nutrient Agar for possible isolation of Salmonella/Shigella, Staphylococcus aureus, total coliform, total faecal count and total heterotrophic bacteria count respectively. These plates were incubated at 37°C for 24 – 48 hours after which the colonies that grew in each of the agar were counted and expressed as colony forming units per gramme (cfu/g).

The bacterial isolates were characterized on the bases of their morphological, cultural, Gram reaction and biochemical characteristicsas described by Cheesbrough (2006).

The antimicrobial susceptibility test was carried out using Kirby's Bauer disc diffusion method modified by Clinical and LaboratoryStandard Institute (CLSI) (CLSI, 2006). Briefly, four (4) variant colonies of the isolateswere transferred into 5ml of sterile normal saline in a tube such that the turbidity of the bacterial suspension is equivalent to 0.5 McFerland standards. A sterile swab stick was moist in the bacterial suspension and on Mueller-Hinton agar and the antibiotic disc was aseptically placed on the Muller Hinton Agar plate containing the isolates and the plate was incubated at 37°C for 24 hours. The diameter zone of inhibition was determined using meter rule and the result was interpreted in accordance with susceptibility break point earlier described by CLSI(2006).

# RESULTS

Total bacterial count (×10<sup>5</sup> cfu/g) was found to be highest in cassava (7.1), followed by garri (6.2) and yam (4.4). The total coliform count (×10<sup>5</sup> cfu/g) recorded 3.7 in cassava, 1.6 in garri, and 1.4 in yam flours. Similarly, total faecal coliform (×10<sup>5</sup> cfu/g) was highest in cassava flour (4.1), while garri had 2.4, and yam recorded 2.2. Also, the *Staphylococcus aureus* count (×10<sup>5</sup> cfu/g) was highest in cassava flour (3.6), followed by yam flour (3.1), and garri flour had 2.8. However, the Salmonella/Shigella count (×10<sup>5</sup> cfu/g) was high in garri flour (3.2), compared to cassava flour (2.5), and yam flour (1.2) (Table 1).

The bacteria isolated were *Staphylococcus aureus, Klebsiella* spp., *Proteus vulgaris, Salmonella* spp., *E. coli* and *Bacillus* spp. The cultural, morphological and biochemical characteristics of the isolates are in Table 2.

The percentage occurrences of bacterial

isolates from garri were found to be 86.7% for *Staphylococcus aureus* and *E. coli*, followed by 80% for *Bacillus*, 60% for *Klebsiella* and *Salmonella* spp, while *Proteus vulgaris* had 66.7%. In the same manner, percentage of bacterial isolates in cassava were 100% for S. *aureus, Proteus vulgaris, Salmonella* and *E. coli* each, followed by 80% for *Bacillus* species while *Klebsiella* recorded 60%. The percentage bacterial isolates in yam had 80% for *Salmonella*, followed by 60% for *Staphylococcus aureus, Klebsiella, Proteus vulgaris* and *E. coli* each, but *Bacillus* occurrence was 40% (Table 3).

The antibiotic susceptibility test was carried out using Kirby's Bauer disc diffusion method modified by the Clinical and Laboratory Standard Institute (CLSI). Most of the bacterial isolates were resistant to Nitrofurantoin (28%), Septrin (36%), Ampicillin (39%), slightly resistant to Nalidixic acid (45%), Perfloxacin and Tetracycline (46%), slightly susceptible to Ofloxacin (52%), Augmentin (63%), Ciprofloxacin (67%) and highly susceptible to Gentamicin (95%). The antibiotic susceptibility patterns of bacterial isolates revealed that Staphylococcus aureus was susceptible to Ciprofloxacin and Gentamicin (100%). Perfloxacin and Ofloxacin (54%), less resistant to Augmentin (46%) and resistant to Nitrofurantoin, Tetracycline, Ampicillin (23%), Nalidixic acid (15%) and Septrin (0%).*Klebsiella* spp. were susceptible to Gentamicin (100%), Tetracycline (78%), Perfloxacin, Ofloxacin and Ciprofloxacin (67%), Augmentin (56%), less resistant to Ampicillin and Nalidixic acid (44%), resistant to Septrin (22%) and Nitrofurantoin (11%). *Proteus vulgaris* on the other hand was susceptible to Gentamicin (100%), Augmentin (80%), Nalidixic acid (70%), Ciprofloxacin (60%), intermediately susceptible to Ofloxacin and Tetracycline (50%). Slightly resistant to Nitrofurantoin (40%), resistant to Ampicillin and Perfloxacin (30%) and Septrin (20%).

Susceptibility patterns of Salmonella spp. indicate that they were susceptible to Gentamicin (100%), Augmentin (83%), Tetracycline (75%), Nalidixic acid (67%), Ciprofloxacin (58%), slightly to Ampicillin (50%), but resistant to Septrin (33%), Ofloxacin (25%), Perfloxacin (17%) and Nitrofurantoin (17%). Similarly, E. coli was found to be susceptible to Gentamicin (100%), Ofloxacin (85%), Septrin and Perfloxacin (69%), Augmentin (62%), Ciprofloxacin (54%), slightly resistant to Nalidixic acid and Nitrofurantoin (46%) and resistant to Ampicillin (39%) and Tetracycline (31%). Nevertheless, Bacillus spp. were susceptible to Septrin and Gentamicin (70%), Ciprofloxacin (60%) slightly susceptible to Ampicillin and Augmentin (50%), slightly resistant to Perfloxacin (40%), but resistant to Ofloxacin (30%), Nalidixic acid and Nitrofurantoin (30%) and Tetracycline (20%) (Table 4).

4.1

2.2

3.6

3.1

Table 1: Total ba	cterial, total coliform	and total faecal col	form counts of gari	i, cassava and yam flo	ours sold
within Keffi met	ropolis (×10 <sup>5</sup> cfu/g)				
Samples	ТНВС	TCC	TFCC	S. aureus	Salmonella spp
Garri	3.5	1.6	2.4	2.8	3.2

**Key:** THBC= total heterotrophic bacterial count, TCC= total coliform count, TFCC= total faecal coliform count

3.7

1.4

Table 2: Cultural, morphological and biochemical characteristic of bacterial isolates from garri, cassava and yam flours in Keffi metropolis

Cultural	PIG	M.P	G.S	Bic	chem	ical tes	st	CI	I utilization	-	Probable isolates
Shape	Size			CAT	IN	V.P	MR	OX	CTGlue.	Lact.	
Circular	0.4mm	pinkish on MAC purple on EMB	straight rod	-	+	-	+	-	- +	AA	Klebsiella spp
Irregular	1mm	whitish in CLED pairs colourless on MAC	curved rod	-	+	+	-	+ -	-	А	Proteus vulgaris
Circular	1-2mm	red, black centre in SSA, colourless & transparent in MAC	straight rod	-	+	-	-	+ -	+	AG	Salmonella species
Circular	0.4mm	yellowish on MSA	cocci	+	+	-	-	- +	+	AA	Staphylococcus aureus
Circular	1mm	greenish on EMB	slightly	-	+	+	-	+	-	AG	Escherichia coli
Circular	4mm	pink on MAC whitish on NA Pinkish on MAC	curved rod smooth rod	+	+	-	-	-	- +	AAG	Bacillus spp.

Where: MP= Morphology, GS= Grams staining, CAT= Catalase, COA= Coagulase, IN= Indole, MR= Methylene red, OX= Oxidase, VP= Voges Proskauer, CT= Citrate test, + = positive, - = negative, MSA = Mannitol salt agar, EMB = Eosin methylene blue agar, NA= Nutrient agar, MAC = MacConkey agar, NA= Nutrient agar, CH= carbohydrate, Gloc= glucose, Lact= lactose, AG= acid and gas production, A= acid production

Table 3: Percentage occurrences of bacterial isolates form garri, cassava and yam flours in Keffi metropolis

Samples	Number of samples			% Occurren	ce		
		Staphylococcus. aureus	Klebsiella spp	Proteus vulgaris	Salmonella spp	E. coli	Bacillus spp
Garri	5	5(100)	3(60)	2(40)	3(60)	5(100)	4(80)
Cassava	5	5(100)	3(60)	5(100)	5(100)	5(100)	4(80)
Yam	5	5(100)	3(60)	3(60)	4(80)	3(60)	2(40)
Total	5	13(86.7)	9(60.0)	10(66.7)	12(80.0)	13(86.7)	10(66.7)

Table 4: Antibiotic susceptibility patterns of bacterial isolates for garri, cassava and yam flours sold

in Keffi metropolis										
Isolates (n)	PN(30µg)	AUG(30µg)	SXT(30µg)	CPX(10µg)	CN(10µg)	OFX(10µg)	PFX(30µg)	NA(30µg)	NIT(30µg)	TET(30µg)
Staph. aureus (13)	3(23)	6(46)	0(0)	13(100)	13(100)	7(54)	7(54)	2(15)	3(23)	3(23)
Klebsiella spp. (9)	4(44)	5(56)	2(22)	6(67)	9(100)	6(67)	6(67)	4(44)	1(11)	7(78)
Proteus vulgaris(10)	3(30)	8(80)	2(20)	6(60)	10(100)	5(50)	3(30)	7(70)	4(40)	5(50)
Salmonella spp. (12)	6(50)	10(83)	4(33)	7(58)	12(100)	3(25)	2(17)	8(67)	2(17)	9(75)
E. coli(13)	5(39)	8(62)	9(69)	7(54)	13(100)	11(85)	9(69)	6(46)	6(46)	4(31)
Bacillus spp. (10)	5(50)	5(50)	7(70)	6(60)	7(70)	3(30)	4(40)	3(30)	3(30)	2(20)

Key: PN= Ampicillin, AUG= Augmentin; SXT= Septrin; CPX= Ciprofloxacin, PFX= Perfloxacin, NIT= Nitrofurantoin, CN= Gentamicin; NA= Nalidixic acid, TET= Tetracycline, OFX= Ofloxacin

### DISCUSSION

Cassava

Yam

4.8

2.9

Garri, cassava and yam flours are a basic staple food in Nigeria and some African countries. An assessment of the bacteriological quality of garri, cassava and yam flours was conducted in Keffi, North-Central Nigeria. These flours are some sort of a ready-to-eat food, and ready-to-eat foods have been reported to be easily available, affordable provide diverse/variable food sources, employment and with a potential for improving food in the society and nutritional status and general social security. It is however, a viable source of food borne pathogen (Abdulsalam and Katerstain, 1993; Arambulo *et al.*, 1994). The total bacterial count, coliform count, total faecal coliform, *Staphylococcus* aureus and *Salmonella/Shigella* counts of the flours were high in the study area. The counts for garri flour ranged between  $1.6-7.1 \times 10^5$  cfu/ml, while cassava flour's counts ranged between  $2.5-6.2 \times 10^5$  cfu/ml. Yam flour also had a count ranged of  $1.2-4.4 \times 10^5$  cfu/ml. Ready to eat foods with plate counts of  $\leq 10^3$  are acceptable, counts of  $10^4$  to  $10^5$  are tolerable while counts  $\geq 10^6$  are unacceptable (ICMSF, 1996).

The presence of contaminants to the order of 10<sup>5</sup>

2.5

1.2

in all of the flour samples however, negates the  $10^3$  stipulated requirements by the African Organization for Standardization. The presence of coliform could therefore be from post process contamination via food handlers and the environment (Obiekezie *et al.*, 2012, 2014, Olopade *et al.*, 2014).

Staphylococcus aureus and E. coli were the most prevalent organisms in garri, followed by Bacillus, Klebsiella and Salmonella with Proteus vulgaris as the least isolate. On the other hand Staphylococcus aureus, Proteusvulgaris, Salmonella spp. and E. coli were found to have 100% occurrence in cassava, followed by Bacillus and Klebsiella species. In yam, the most prevalent organism was Salmonella spp, followed by Staphylococcus aureus, Klebsiella, Proteus vulgaris while Bacillus spp. had the least occurrence.

Salmonella spp., Staphylococcus aureus, E. coli and Bacillus spp. were found to be the most occurring organisms in this study. The presence of B. cereus and S. aureus in high proportion calls for concern because some strains of these organisms are known to be toxigenic and have been implicated in food borne intoxication (Oranusi et al., 2007; Mensah et al., 1999).

*Bacillus* spp. particularly *B. cereus* is common environmental contaminants while *S. aureus* is of human origin, their presencecould therefore be from the food handlers, utensils and the environment (Olopade *et al.*, 2014).Isolation and identification of the isolates revealed the presence of *Staphylococcus aureus*, *Klebsiella* spp., *E. coli, Salmonella* spp., *Proteus vulgaris* and *Bacillus* spp. Similar isolates were reported by several authors; Orji *et al.*, (2014), Olopade *et al.*, (2014), Odetunde *et al.*, (2014), Abba-Kareem *et al.*, (1990) and Ogugbue *et al.*, (2011). Also, the fermentation of garri is by mixed microbial cultures and could have accounted for the diverse microbial population contaminating the product.

Previous reports have revealed high bioload and a vast array of microorganisms in market samples of garri and other cassava based products (Ijabadeniyi, 2007; Ogiehor et al., 2007; Omafuvbe et al., 2007; Amadi and Adebola, 2008; Ogugbue et al., 2011 and Odom et al., 2012). Proteus vulgaris has been reported to be isolated from dried cassava powder (garri) in Ogun State (Thoha et al., 2012). This is in agreement with the result obtained in this work. Salmonella causes food poisoning and typhoid fever as reported by Ekperigin and Nagaraja (1998) and Parry et al., (2002). Ekundavo and Okoroafor (2012) revealed the presence of Staphylococcus aureus and Escherichia coli in Fufu (made from cassava flour) in some communities around Umudike. The presence of Escherichia species in food samples indicate feacal contamination which could be attributed to unhygienic nature of the food handlers and food preparation areas as recorded by Abdullahi et al., (2004) and Edema et al., (2005).

The antibiogram of isolates from ready-to-eat food revealed that some of the organisms isolated in this study have become resistant to all the tested antibiotics, and this showed that they have become multi-resistant to these therapeutic agents, thus rendering these drugs ineffective as treatment of choice for infections caused by these pathogens. The presence of antibiotic resistant bacteria in food, water and the environment has been widely documented (Bolaji *et al.*, 2011; McGowan, 2006; Bawdon *et al.*, 1982; Dantas *et al.*, 2008; Zhang *et al.*, 2009).

Gentamicin (95%), Augmentin (63%), Ciprofloxacin (67%) and Ofloxacin (52%) had great efficacy against most of the bacterial isolates and this suggest that these drugs may be useful for treatment of infection cause by the bacterial isolates. Also, Tetracycline was effective against *Klebsiella* spp. (78%) and *Salmonella* spp. (75%). Nalidixic acid was effective against *Proteus vulgaris* (70%) and *Salmonella* spp. (67%).

The sensitivity pattern of the bacterial isolates to the antibiotics tested is comparable with reports of earlier researchers (Udo et al., 2001, Invang, 2009, Tagoe et al., 2011, Makut et al., 2013 and 2014). For most bacteria, there is evidence that increased usage of a particular antimicrobial correlates with increased levels of bacterial resistance (Granizo et al., 2000); perhaps this explains the high resistance to Nitrofurantoin (28%) and Septrin (36%) by the isolates because of its common and prevalent use. Resistance to some of these antibiotics is not new, as Ehinmidu (2003) as observed such effect earlier. The high susceptibility of the isolates to Gentamicin and Augmentin observed in this study might be due to their requirement for parenteral administration which hinder their misuse and abuse considered to be the major source of microbial resistance to conventional antibiotics as observed by Ngwai et al., (2010).

#### CONCLUSION

This present work revealed high bioload and vast array of bacteria in market garri, cassava and yam flours. These are threatening and alarming and suggest early warning signals indicating the level of safety with regards to public health in view of their acceptability and consumption. The high array and bioload of these microorganisms recorded may be associated with inadequate post processing handling practices such as spreading on the floor, mat and sometimes on high density polyethene spread on the floor after frying to allow it to cool before sieving into finer grains; and the open display in bowls and basins in the market, measurement with the aids of bare hands, coughing and sneezing while selling and the use of non microbiologically determined bags for packaging and haulage.

Optimization of the production process by using a starter culture with reduced post process handling is imperative for the realization of highly nutritious and microbial-free products.

The International Commission on Microbiological Specifications for Food (ICMSF) and the African Organization for Standardization (AOS) recommended absence of coliform in ready to eat foods. The presence of coliform in garri, cassava and yam flour samples therefore makes them of poor quality for human consumption.

The high bioload warrants renewed vigilance on the efficacies of food processing conditions, handling techniques and handlers technical knowhow, hygiene practices and safety of finished products. In addition, strict application and implementation of quality control, quality assurance, good manufacturing practice and the hazard analysis of critical control point principles will help to ensure the safety of these food flours consumed by several people in Keffi metropolis and Africa in general.

Also, adequate sanitation practice should be enforced concerning the sale of cassava based foods. Personal hygiene of hawkers and sanitation of utensils *FULafia Journal of Science & Technology Vol. 2 No.1 March, 2016*  are important. Hawkers should be enlightened on hygienic practices. It is therefore recommended that these food flours be sold in well packaged bags and not as exposed in basins/

bowls. Nonetheless, in view of the antibiogram, it is therefore, necessary to intensify surveillance of isolates to detect emerging antimicrobial resistance phonotype especially Nigeria.

### REFERENCES

- Abba–Kareem, V. N., Okagbue, R. N. and Ogbadu, G.H. (1990). Studies on the microbiology of cassava flour. *Nigerian Food Journal*, 9: 85–91.
- Abdullahi, I.O., Umoh, V.J., Ameh, J.B. and Galadima, M. (2004). Hazards associated with Killishi preparation in Zaria, Nigeria. *Nigerian Journal of Microbiology*, 18(1-2): 339-345.
- Abdussalam, M. and Kaferstein, F.K. (1993). Safety of street foods. World Health Forum, 14:(2): 191-194.
- Adebayo-Oyetoro, A.O., Oyewole, O.B., Obadina, A.O. and Omemu, M.A. (2013). Microbiological safety assessment of fermented cassava flour "Lafun" Available in Ogun and Oyo States of Nigeria. *International Journal of Food Science*, 20(13):1-5.
- Amadi, J.E. and Adebola, M.O. (2008). Effect of moisture content and storage conditions on the storability of garri. *African Journal of Biotechnology*, 724: 459-4594.
- Ano, A.O. (2003). Studies on the effects of liming on the yield of two cassava cultivars. In "NRRI Annual Report.
- Akissoe, N.H., Hounhauigan, J.D., Bricas, N., Vernier, P., Nago, M.C. and Olorunda, O.A. (2001). Physical, chemical and sensory evaluation of dried yam (Discorea rotundata) tubers, flour and amala- a flour-derived product. *Tropical Science*, 41:151-156.
- Arambulo, P. Almeida, C.R., Cuellar, J. and Belotton, A. J. (1994). Street Foods Vending in Latin America. *Bulletin of PAHO*, 38: 344–354.
- Babajide, J.M., Oyewole, O.B. and Obadina, O.A. (2006). An assessment of the microbiological safety of dry yam (gbodo) processed in South West Nigeria. *African Journal of Biotechnology*, 5 (2): 157 161.
- Bawdon, R. E., Crane, L. R. and Palchaudhuri, S. (1982). Antibiotic resistance in anaerobic bacteria: molecular biology and clinical aspects. *Clinical Infecteous Dis*ease, 4(6): 1075-1095.
- Bolaji, A.S., Akande, I.O., Iromini, F., Adewoye, S.O. and Opasda, O.A. (2011). Antibiotic resistance pattern of bacteria isolated from hospital waste water in Edo South Western Nigeria. *European Journal of Experimental Biology*, 1(4):66-71.
- Cheesbrough, M. (2006). District Laboratory Practice in Tropical Countries, 2nd Ed. Cambridge University Press, Cambridge, ISBN 10:0521676312, Pp. 440.
- Clinical and Laboratory Standard Institute (CLSI) (2006). Performance Standard for Antimicrobial Disc Diffusion Test; Approved standard, 9th ed. CLSI document.
- Dantas, G., Sommer, M.O.A, Oluwasegun, R.D. and Church, G.M. (2008). Bacteria subsisting on antibiotics. *Science*, 320: 100-103.
- Edema, M., Atagese, A.O. and Idowu, C. (2005). Microbial quality of food wave processed foods in Book of Abstract of the 29th Annual Conferences and General Meeting on Microbes as Agents of Sustainable Development, Organized by Nigerian Society For Food Microbiology (NSM), UNAAB, Abeokuta from 6–10th November.
- Egesi. O., Mbanaso, E., Ogbe, F., Okogbenin, E. and Fregene, M. (2006). Development of cassava varieties with high value root quality through induced mutation and marker-aided breeding", NRCRI, Umudike Annual Report.
- Ehinmidu, J.O. (2003). Antibiotic susceptibility patterns of urine bacteria isolates in Zaria, Nigeria. *Tropical Journal of Pharmaceutical* Research, 2: 223-228.
- Ekperigin, H.E. and Nagaraja, K.V. (1998). Microbial foodborne pathogens, *Salmonella*. Veterinary Clinical North American Food Animal Practice, 14(1): 17-29.
- Ekundayoa, E.O. and Okoroafor, O.I. (2012). Microbiological and physico retting for production of fufu in some communities around. *Journal of Sustainable Agricultural Environment*, 13(1): 38–44.
- FAO (2008). Corporate Document Repository. The impact of HIV/AIDS on agricultural Sectors. http://www.fao.org/ docrep/005/74636E/y4636e05.htm
- Granizo, J.J., Águilar, L., Casal, J., Dal-Re, R. and Baquero, F. (2000). Streptococcus pyrogenes resistance to erythromycin in relation to macrolide consumption in Spain (1986-1997). *Journal of Antimicrobial Chemotherapy*, 46: 959-964
- Ijabadeniyi, A.O. (2007). Microbiological Safety of Garri Lafun and Ogiri in Akure Metropolis, Nigeria. *African Journal* of *Biotechnology*, 622:2633-2635.
- International Commission on Microbiological Specifications for Foods (ICMSF) (1996). Microorganisms in Foods 5: Microbiological Specifications of Pathogens.Inyang, C.U. (2009). Antibiogram of bacteria isolated from borehole water. *Nigerian Journal of Microbiology*, 23: 1810-1816.
- Jekayinfa, S.O. and Olajide, J.O. (2007). Analysis of energy usage in the production of three selected cassava based foods in Nigeria. *Journal of Food Engineering*, 82: 217-226.
- Makut, M.D., Nyam, M.A., Amapu, T.Y. and Ahmed, A. (2014). Antibiogram of Bacteria Isolated from Locally Processed Cow Milk Products Sold in Keffi Metropolis, Nasarawa State, Nigeria. *Journal of Biology*, *Agriculture and Healthcare*, 4(4): 19-25.
- Makut, M.D., Nyam, M.A, Obiekezie, S.O. and Abubakar, A.E. (2013). Antibiogram of bacteria isolated from Kununzaki drink sold in Keffi metropolis. *American Journal of Infectious Diseases*, 9(3): 71-76.
- McGowan, J.E. (2006). Resistance in non fermenting Gram-negative bacteria: multidrug resistance to the maximum. *American. Journal Infecteous Control*, 34: 529-537.

- Mensah, P., Owusu-Darko, K., Yeboah-Manu, D., Ablordey, A., Nkrumah, F.K. and Kamiya, H. (1999). The role of street food vendors in the transmission of enteric pathogens. *Ghana Medical Journal*, 33: 19-29.
- Mestres, C., Dorthe, S., Akissoe, N. and Hounhouigani, J.D. (2004). Prediction of sensorial properties (color and taste) of amala, a paste from yam chips flour of West Africa, through flour biochemical properties. *Plant Foods Human Nutrition*, 59(3): 93–99.
- Ngwai, Y.B., Akpotu, M.O., Obidake, R.E., Sounyo, A.A., Onanuga, A. and Origbo, S.O. (2010). Antimicrobial susceptibility of Escherichia coli and other coliforms isolated from urine of asymptomatic students in Bayelsa State, Nigeria. *African Journal of Microbiology Research*, 5(3): 184-191.
- Obiekezie, S.O., Adejo, G.O., Ilouno, E.L. and Mohammed, A. (2014). Assessment of bacterial population and metal ion contents of water from Keffi sub-urban rivers, Nigeria. *Nasara Scientifique:* Journal of Natural and Applied Sciences, 3(1): 34-43.
- Obiekezie, S. O., Odu, N.N. and Kanhu, K.E. (2012). Distribution of Salmonella spp. from some poultry farms in Keffi. *International Journal of Chemical Sciences*, 5(2): 253-256.
- Obiekezie, S.O., Asamudo, N.U., and Akpan, M. (2010). Concomitant bacteraemia in malaria parasitaemia among the students of University of Uyo, South south Nigeria. *Nigerian Journal of Microbiology*, 24(1):2231-2234
- Odetunde, S.K., Adebajo, L.O., Lawal, A.K. and Itoandon, E.E. (2014). Investigation into Microbiological and Chemical Characteristics of Cassava Flour in Nigeria. *Global Advanced Research Journal of Microbiology*, 3(3): 31-40.
- Odom, T.C., Nwanekezi, E.C., Udensi, E.A., Ogbuji, C.A., Ihemanma, C.A., Emecheta, R.O. and Aji, R.U. (2001). Biochemical qualities of cassava fufu sold in Imo and Abia States of Nigeria. *Global Advanced Research Journal of Environmental Science and Toxicology*, 1(7): 178-182.
- Ogbe, F.O., Emehute, J.K.U. and Legg, J. (2007). "Screening of cassava varieties for whitefly populations" NRCRI *Annual Report*, 2007.
- Ogiehor, I.S. and Ikenebomeh, M.J. (2006). The effects of Different packaging materials on the shelf stability of garri. *African Journal of Biotechnology*, 5(22):2412-2416.
- Ogiehor, I.S., Ikenebomeh, M.J. and Ekundayo, A.O. (2007). The bioload and aflatoxin content of market gari from some selected states in Southern Nigeria: public health significance. *African Health Science*, 74: 223-227.
- Ogori, A.F. and Gana, J. (2013). Microbiological loads of road-side dried cassava flour from cassava Balls and chips. *American Open Journal of Agricultural Research*, 1(7):24-29.
- Ogugbue, C.J., Mbakwem-Aniebo, C. and Akubuenyi, F. (2011). Assessment of microbial air contamination of post processed garri on sale in markets. *African Journal of Food Science*, 5(8): 503–512.
- Okigbo, R.N. (2003). Fungal association with peels of post harvest yams in storage. *Global Journal of Pure and Applied Sciences*, 9(1):19-23.
- Olopade, B.K., Oranusi, S., Ajala, R. and Olorunsola, S.J. (2014). Microbiological quality of fermented Cassava (Gari) sold in Ota, Ogun State, Nigeria. *International Journal of Current Microbiology Applied Sciences*, 3(3): 888-895.
- Oranusi, S., Galadima, M., Umoh, V.J. and Nwanze, P.I. (2007). Food safety evaluation in boarding schools in Zaria, Nigeria using the HACCP system. *Scientific Research and Essay*, 210: 426-433.
- Orji, J.O., Okonkwo, E.C., Anyim, C. and Ekuma, U.O. (2014). Microbiological assessment of cassava based foods (Garri And Akpu) within Abakaliki metropolis. *Journal of Applied Science and Research*,2(2): 90-98.
- Omafuvbe, B.O., Adigun, A.R., Ogunsuyi, J.L. and Asunmo, A.M. (2007). Microbial diversity in ready- to-eat fufu and lafun-fermented cassava products sold in Ile-Ife, Nigeria. *Research Journal of Microbiology*, 29(11): 831-837.
- Oyeyiola, G.P., Oyeniyi, O.R., Arekemase, M.O. and Ahmed, R.N. (2014). Comparative study on the microbiological and nutritional properties of stored chunks and flours. *World Journal of Biological Research*, 2(2):1-6.
- Parry, C.M., Hien, T.T., Dougan, G., White, N.J. and Farrar, J.J. (2002). Typhoid fever. *New England Journal of Medicine*, 347: 1770-1782.
- Somorin, Y.A., Bankole, M.O., Omemu, A.M. and Atanda, O.O. (2011). Impact of milling on the microbiological quality of yam flour in Southwestern Nigeria. *Research Journal of Microbiology*, 6: 480-487.
- Tagoe, D.N.A., Nyako, S.A., Arthur, S.A. and Birikorang, E. (2011). A study of antibiotic susceptibility pattern of bacteria isolates in sachet drinking water sold in Cape Coast metropolis of Ghana. *Research Journal of Microbiology*, 6: 153-158.
- Thoha, T.B., Georgina, E.H.I.A., Sikirat, M.O., Toyin, A.M., Davies, O.O., Omobowale, A.K., Oluwabunmi, O. and Oluwadun, A. (2012). Fungi associated with the deterioration of Garri (a traditional fermented cassava product) in Ogun State, Nigeria. *Researcher*, 4(2): 8-12.
- Udo, S., Andy, I., Umo, A. and Ekpo, M. (2001). Potential human pathogens (bacteria) and their antibiogram in ready-to-eat salads sold in Calabar, South-South, Nigeria. *International Journal of Tropical Medicine*, 5(2).
- Ugwu, B.O. and Ukpabi, U.J. (2002). "Potential of soy-cassava flour processing to sustain increasing cassava production in Nigeria" *Outlook on Agriculture*, 31(2):129-133.
- World Health Organization (WHO) (2001). WHO surveillance programmed for control of food-borne infections and intoxication in Europe. 7th Report, 1993-1998. FAO/WHO Collaborating Centre, Berlin.
- Zhang, Y., Marrs, C.F., Simon, C. and Xi, C. (2009). Wastewater treatment contributes to selective increase of antibiotics resistance among *Acinetobacter* spp. *Science of Total Environment*, 407: 3702-3706.





AGRICULTURAL AND BIOLOGICAL SCIENCES

# COMPARATIVE DIAGNOSIS OF MALARIA USING ROUTINE MICROSCOPY AND RAPID DIAGNOSTIC TECHNIQUE WITH LACTAN DEHYDROGENASE.

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# ABSTRACT

This study investigated the comparative analysis of rapid diagnostic techniques (RDT) and microcospy for malaria diagnosis using a population of clients attending National Institute for Pharmaceutical Research and Development (NIPRD), Research Clinic. Two hundred and fifty-one clients with a clinical suspicion of malaria based on fever from Idu and surrounding communities were tested with both methods. Diagnostic test outcomes were separated into different age groups to assess the impact of age on test outcome. The significance of age-groups was assessed with Chi-Squared test at 95% confidence interval. Of the 251 clients 110(43.82%) were positive by RDT, compared to 87(34.66%) by microscopy. The difference between the two methods was not statistically significant (Tab. t = 2.306 > Cal t = 0.3833; p > 0.05). Rapid diagnostic technique RDT test, detected malaria more in age group 11-20 years (17.3%) and 21-30 years old 38(15.14%), though lower in older ages 31 -  $\geq$ 50 years (<7%). Using Chi-Squared ( $\chi$ 2), there was no significant difference in the detection of malaria in the age groups (Tab  $\chi 2=9.488 > \text{Cal } \chi 2 \text{ df.4}, 1 = 3.32, p > 0.05$ ). In relation to sex, seroprevalence of malaria parasite was higher 41(35.96%) males compared to 46(35.58%) females with no significant difference (Tab  $\chi 2 = 9.488 > \text{Cal } \chi 2 = \text{df.4}, 1 = 4.58; p > 0.05$ ). In all, RDT detected higher values in both sexes 51(44.74%) and 59(43.07%) for males and females respectively. The Pf (HRPII/PAN-LDH); HRP2-based RDT showed higher sensitivity compared to microscopy in detection of malaria and may perhaps be more appropriate for screening of malaria infection. Large scaleassessment of RDT for malaria screening is endorsed for Primary Health Care (PHC) centres, and field research on malaria studies.

KEYWORDS: Rapid diagnostic technique (RDT), Microscopy, Malaria

# **INTRODUCTION**

Malaria is one of the highest killer diseases affecting most tropical countries, especially, Africa. It affects over 500 million people worldwide and over one million children die annually from malaria parasite (Amazu et al., 2009). Of the entire human malaria parasite, Plasmodium falciparum, is the most pathogenic and is frequently fatal if untreated in time (Nandwani et al., 2005). Clinical diagnosis is imprecise but remains the basis of therapeutic care for the majority of febrile patient in malaria endemic areas. where laboratory is often out of reach. Rational therapy of malaria is essential to avoid non- target effects, to delay the advent of resistance and to save costs on alternative drugs. Accurate diagnosis is the only way of effecting rational therapy. Confirmatory diagnosis before treatment initiation recently regained attention. partly influenced by the spread of drug resistance and thus the requirement of more expensive drugs unaffordable to resource poor countries (Barmish et al., 2004). Traditional practice for outpatient has been to treat presumptively for malaria based on a history of fever but a significant proportion of those treated may not have parasites (over 50% in many settings) and hence waste a considerable amount of drugs (Shillcut et al., 2008). This old clinical based practice is still relevant today especially in infants where time spent on getting a confirmatory laboratory diagnosis could lead to increased fatality.

WHO currently makes the tentative recommendation that parasite based diagnosis should be used in all cases of suspected malaria with the possible exception of children in high- prevalence areas and certain other situations (WHO, 2006). The traditional method of microscopic identification of parasites, however, is not only daunting in poor power setting but also time consuming and requiring a lot of expertise/ training. Thus microscopy in Africa is generally limited to larger clinics. This peripheral blood smears/ microscopy, however, still remains the gold standard in laboratory diagnosis of malaria (Nandwani *et al.*, 2005).

A relatively new and easy to perform tests has been developed to diagnose P. falciparum rapidly without recourse to a microscope. Most recently, the test could detect P. vivax infections (Cheesbrough, 1998). The diagnosis is based on the immunochromatographic detection of antigen HRP2 (histidine – rich protein 2) or specific pLDH (parasite lactate dehydrogenase). Both HRP2 and pLDH are produced by the parasites during their growth and multiplication in red cells (Cheesbrough, 1998). It is against this back drop that the study aims at comparing the rapid test to microscopy the gold standard in the diagnosis of malaria in Abuja, north central Nigeria.

# **MATERIALS AND METHOD**

Abuja the Federal Capital Territory (FCT) is located geographically at the centre of Nigeria. It lies between latitude 8°02" and 9°25"N; longitude 6°45"

and 7°45"E. The F.C.T falls in the semi-seasonal equatorial climate zone with associated contrasting wet and dry periods.

A total of 251 blood samples were collected randomly into EDTA bottles and taken to the diagnostic laboratory in NIPRD clinic for processing and analysis.

Thick and thin films were prepared by the method of Menderietta *et al.*, (2007). The serum was separated from the blood samples into cryotubes for RDT.

 $2\mu$ L of blood was placed using an applicator on a new glass slide, another new slide was run forward against the old slide with blood sample, creating a head, body and tail, Slides were placed on a rack to dry for about 30 minutes. Slides were fixed in 70% alcohol and allowed to dry to avoid washing off. Giemsa stain was used to flood the slide and allowed to dry for 30 minutes. Slides were rinsed with distilled water with pH of 7.2 then allowed to dry. Oil immersion was used on slide and then mounted on a microscope with X100 objective lens.

 $12\mu$ L of blood was placed on a new glass slide, another slide was used to smear blood sample in a ring form. Slides were placed on a rack to dry for about 45 minutes. Slides were flooded using Giemsa stain and allowed to dry for about 35 minutes then rinsed with distilled water pH of 7.2, then allowed to dry. Oil immersion was applied and slides were mounted on a microscope with X100 objective lens and viewed.

# Procedure for Rapid Diagnostic Test (RDT) Kits

 $5\mu$ L of separated serum of each blood sample was placed into sample well,  $80\mu$ L of assay buffer was added into developer well and results were read within 10 - 15 minutes.

Parasites observed in microscopy were identified by their morphological characteristics according to illustrations from Coatney *et al.*,(1971).

Chi-square test was used to identify any significant differences in malaria prevalence among age groups and student t-test was used to calculate any significant difference using microscopy and RDT in malaria diagnosis. Values of  $P \ge 0.05$  were considered not significant.

# **RESULTS AND DISCUSSION**

Two hundred and fifty-one clients with clinical suspicion of malaria, based on fever from Idu and surrounding communities had their blood samples tested with both methods. Of the 251 clients 110(43.82%) were positive by RDT, compared to 87(34.66%) by microscopy, (Fig. 1). Though this difference was noted for the two methods, it was not statistically significant (Tab. t = 2.306 > Cal t = 0.3833; P> 0.05) between microscopy and RDT detection techniques.

Rapid diagnostic technique RDT test(fig, 2) detected

malaria more in age group 11-20 years 43 (17.13%) and 21-30 years old 38(15.14%) respectively, but lower in older ages 31 -  $\geq$ 50 years (<7%) with no significant difference (Tab  $\chi$ 2=9.488 > Cal  $\chi$  2 df.4,1 = 3.32, p > 0.05) in the detection of malaria parasite in the age groups (Fig, 2). In relation to sex, seroprevalence of malaria parasite was 41(35.96%) in males compared to 46(35.58%) in females using microscopy while the RDT detected 51(44.74%) in males than 59(43.07%) prevalence in females respectively (Table 1). There was no significant difference in detecting malaria with either of the method (Tab  $\chi$ 2 = 9.488 > Cal  $\chi$ 2 =df.4, 1 = 4.58; p > 0.05). In all, RDT detected higher values in both sex 51(44.74%) and 59(43.07%), for males and females respectively.



Figure 1: Comparative Diagnosis of Malaria Using RDT and Microscopic Techniques



Fig 2: The comparative diagnosis of malaria using RDT and microscopy based on age.

Table 1:Comparative diagnosis of malaria using rapid diagnostictechnique(RDT) and microscopy test based on sex.

DIAGNOSTIC	MALE		FEI	MALE	TOTAL	
TEST	Number sampled	Number (%) positive	Number sampled	Number (%) positive	Number sampled	Number (%) positive
RDT	114	51 (44.74)	137	59 (43.07)	251	110 (43.82)
MICROSCOPY	114	41 (35.96)	137	46 (35.58)	251	87 (34.66)

Mendiratta, et al., (2007) reported the usefulness of HRP2 antigen detection kit Paracheck Pf for the rapid diagnosis of falciparum malaria with 92.6% sensitivity and a specificity of 98.68%. Besides the financial savings from unnecessary treatments, the use of non – microscopical rapid malaria tests is of value in the early investigation and management of malaria epidemics. It is worthy to note also that these rapid tests are also of value in the diagnosis of severe and complicated falciparum malaria in those who have taken antimalarials (Cheesbrough, 1998). The diagnostic accuracy of this method was measured against routine microscopy as gold standard. Some earlier studies have also compared RDTs using microscopy as gold standard (McMorrow et al., 2008; Bell *et al.*, 2005). In this study RDT gave a higher detection value than microscopy. Similar report has been recorded for HRP-2 based rapid diagnostic technique (Tangpukdee et al., 2009; Ruiz et al., 2002). A number of factors are known and associated with low sensitivity of microscopy including the inherent limitations of microscopy (Bell et al., 2005), existence of low density infections from indiscriminate treatment of malaria and inappropriate use of antimalarial (Kyabayinze et al., 2008) which result in low parasitaemia. The observation of low detection of malaria with microscopy reveals possible limitation of the method in diagnosis of malaria infection in patients. With RDTs, it is possible forclinicians' to see both negative and positive malaria results (Reyburn et al., 2007; WHO, 2000).

RDTs have been known to identify more positive cases of malaria in excess of microscopy gold standard. This has been attributed to patients with persistently circulating antigen due to prior use of anti-malarials as well as the level of immunity (Batwala et al., 2010). Earlier report indicated that RDT detect majority of malaria cases but also led to treatment of a small percentage of patients without malaria infection (Batwala et al., 2010). However, HRP2-based RDTs remain positive after treatment. HRP2 signal has been noted to persist during the first week of treatment (Karbwang et al., 1996; Pullan et al., 2010; Mayxay et al., 2001). This is an inherent weakness in HRP2-based tests. Some countries have adopted RDT as a method for parasitological diagnosis of malaria in addition to microscopy (Uganda Ministry of Health, 2010). Due to large number of malaria FULafia Journal of Science & Technology Vol. 2 No.1 March, 2016

patients in Africa, many are treated presumptively. Although microscopy has its limitations (Mens *et al.*, 2007), it is known to detect low level of parasitaemia in a blood sample with different *Plasmodium* species infections (Batwala *et al.*,2010).

This study has been able to show that RDT detected higher malaria values in both sexes 51(44.74%) and 59(43.07%) for males and females respectively. The Pf

showed higher sensitivity compared to microscopy in detection of malaria and is recommended for screening of malaria infections and for large scale assessment for Primary Health Care (PHC) centres, and field studies on malaria.

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# REFERENCES

- Amazu, L.U., Ebong, O.O., Azikiwe C.A., Unekwe, P.C., Simialayi, M.I. and Nwosu, P.J., (2009). Effects of methanolic seeds extract of CaricaPapaya on *Plasmodium* infected mice. *Asian Pacific Journal of Tropical Medicine*, 2 (3):1-6.
- Barnish,G., Baker,I. and Iboro, J.(2004). Newer drug combinations for malaria.*British Medical Journal*, 328:1511-1512.
- Batwala, V., Magnussen, P. and Nuwaha, F.(2010). Are rapid diagnostic tests more accurate in diagnosis of plasmodium falciparum malaria comparedto microscopy at rural health centres? *Malaria Journal*, 9:349.
- Bell, D.R., Wilson, D.W. and Martin, L.B.(2005). False-positive results of a Plasmodium falciparum histidinerich protein 2-detecting malaria rapid diagnostic test due to high sensitivity in a community with fluctuating lowparasite density. *American Journal of Tropical Medicine and Hygiene*, 73:199 -203.
- Cheesbrough, M. (1998) *District Laboratory Practice in tropical countries Part 1*. Cambridge University Press, UK, 453pp
- Coatney G.R., Collins W.E., Warren M., Contacos P.G. (1971). The Primate Malarias. Washington DC: Government Printing Office.
- Karbwang, J., Tasanor, O., Kanda, T., Wattanagoon, Y., Ibrahim, M., Na Bangchang, K., Thanavibul, A. and Rooney W. (1996). Para Sight-F test for the detection of treatment failure in multidrug resistant Plasmodium falciparum malaria. Transaction of the Royal Society of Tropical Medicine and Hygiene, 90(5):513-515.
- Kyabayinze, D.J., Tibenderana, J.K., Odong, G.W., Rwakimari, J.B. and Counihan, H. (2008).Operational accuracy and comparative persistent antigenicityof HRP2 rapid diagnostic tests for Plasmodium falciparum malaria in a hyperendemic region of Uganda.*Malaria Journal*, 7:221.
- Mayxay, M., Pukristtayakamee, S., Chotivanish, K., Loareesuwan, S. and White, N.J (2001). Persistence of Plasmodium falciparum HRP-2 in successfully treated acute falciparum malaria. *Tropical Medicine and Hygiene*, 95, 179–182.
- McMorrow, M.L., Masanja, M.I., Abdulla, S.M., Kahigwa, E. and Kachur, S.P.(2008). Challenges in routine implementation and quality control of rapid diagnostic tests for malaria–Rufiji District, Tanzania. *American Journal of Tropical Medicine and Hygiene*, 79:385-90
- Mendiratta, D. K., Bhutada, K. and Narang, P. (2007): Evaluation of different methods for diagnosis of Plasmodium falciparum malaria. *Nigerian Biomedical Science Journal*, 3(3): 10 12
  Mens, P., Spieker, N., Omar, S., Heijnen, M., Schallig, H. andKager, P.A.(2007). Is molecular biology the best alternative for diagnosis of malaria to microscopy? A comparison between microscopy, antigen detection and molecular tests in rural Kenya and urban Tanzania. *Tropical Medicine and InternationalHealth*, 12:238-44.
- Nandwani, S., Mathur, M. andRawat, S. (2005).Evaluation of the polymerase chain reaction analysis for diagnosis of falciparum malaria in Delhi India. *Indian Journal of Medical Microbiology*, 23 (3):176-178.
- Okell, L.C., Ghani, A.C., Lyons, E. and Drakeley, C.J. (2009).submicroscopic infection in Plasmodium falciparum endemic populations: a systematic review and meta-analysis. *Journal of Infectious Disease*, 200(10) 1509 17.
- Pullan, R.L., Bikirwa, H., Staedke, S.G., Snow, R.W. and Brooker, S. (2010) Plasmodium infection and its risk factors in eastern Uganda. *Malaria Journal*, 4:2.
- Reyburn, H., Mbakilwa, H., Mwangi, R., Mwerinde, O., Olomi, R., Drakeley, C. and Whitty, C.J. (2007). Rapid diagnostic tests compared with malaria microscopy for guiding outpatient treatment of febrile illness in Tanzania: randomized trial. *British Medical Journal*, 334:403.

- Ruiz, A., Priotto, G., Kiguli, J., Bonte, L., Legros, D.(2002). Validity, reliability and ease of use in the field of five rapid tests for the diagnosis of Plasmodium falciparum malaria in Uganda. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 96:254-257.
- Shilcultt, S., Morel, C., Goodman, C., Coleman, P., Bell, D. and Whitly, C.J. (2008) Cost effectiveness of malaria diagnostic methods in sub-saharan African in an era of combination therapy.*Bulletin Word Health Organization*, 86:101-110.
- Snow, R.W., Guerra, C.A., Noor, A.M., Myint, M.Y. and Hay, S.I.(2005). The global distribution of clinical episodes of Plasmodium falciparum malaria.*Nature*, 434:214-217.
- Tangpukdee, N., Duangdee, C., Wilairatana, P. and Krudsood, S. (2009). Malaria diagnosis: a brief review. *Korean Journal of Parasitology*,47:93-102.
- Uganda Ministry of Health: (2010) National Malaria Control Diagnostic Guidelines.Kampala. World Health Organization. (2006). The role of laboratory diagnosis to support malaria disease management: focus on the use of rapid diagnostic tests in areas of high transmission. *Geneva: World Health Organization*.
- World Health Organization(2000). WHO/MAL/2000.1091. New perspectives in malaria diagnosis. World Health Organization, Geneva, Switzerland





# AGRICULTURAL AND BIOLOGICAL SCIENCES

# CONSUMER PERCEPTION OF PERSONALITY AND KNOWLEDGE IN THE ACQUISITION PRIORITY OF HOUSEHOLD APPLIANCES IN ABUJA, NIGERIA

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# ABSTRACT

This study evaluated the personality and evaluation criteria, financial knowledge, decision making process and the perception of personality and knowledge of consumers in the acquisition of household appliances in Abuja. The survey research design was adopted and instrument was formulated which comprised forty nine (49) questions administered to 200 respondents and a Likert scale covering the independent and dependent variables. It was validated and the reliability of the instrument was determined at 0.801Chronbach's alpha. The aggregate mean of the Likert scale was 4.01 and the mean decision was determined at  $\geq$  3.000. Findings revealed that for most consumers, personality factor of social [males 10%, females 4%], psychological [males 4%, females 0%], financial anxiety [males 42%, female 21%] and the functionality of the product [males 10%, females 18%] donot seem to add to the personality of consumers in the acquisition priority of household appliances. Similarly, most males and female consumers have similar evaluation criteria when acquiring household appliances. However, price [males 11%, females 15%] and quality [males 21% and females 20%] stand out as top priority criteria in the acquisition of household appliances. More males [30%] than females [42%] seemed to be more influenced by knowledge about household appliance before acquisition. They used experiential sources [males 33%, females 13%] more than personal sources [males 31%, females 23%] as sources of information before acquisition. Generally, consumer perception on the influence of personality and financial knowledge in the acquisition priority of household appliance was ranked in the order of highest influence: durability, satisfaction and financial status. The consumer's acquisition of household appliances and implications in other socioeconomic factors are discussed.

Key words: Consumer, Perception, Personality, Influence, Acquisition, Household Appliance.

# INTRODUCTION

The complexity of the dynamics of the acquisition of goods and services by the individual or group of consumers give insight into the behaviour of the decision making process of both consumers and the manufacturers in the market system. The interactions and practices in the acquisition of goods and services by consumers presuppose that the consumer is subjected to certain influences, flaunts, exploitation, misdirection and mistakes in the choices they make. There appears to be a flaunting of basic rights they are entitled to in quality, price, manufacturers' claims of protection against unsafe goods, inadequate and inaccurate information about the product(s) provided and much more. Hence, the consumers need to scrutinize as a form responsibility (to themselves) in order to ensure functionality for the purpose the product is intended to serve as well as value for the price paid.

Consumer acquisition, then, is one who identifies a need/desire, decodes from the point of need to purchasing it, installation, use and perhaps disposes of it. Thus, making it increasingly necessary for producers to engage in market segmentation strategies. Certain target groups branded products that captivates the interest and personalities of consumers are produced to meet their specific needs and desires in appropriate ways. These could be texture, colour, smell, taste, and sizes, (etc) that appeals to them and influences their liking or dislike of the product. This symbolism in acquisition are assessed consciously or unconsciously and impacted through opinion, desires as well as the manner society feels and defines the people. Wherefore, consumer behaviour is influenced by internal influences such as demographic and psychological factors that includepersonality, motivation, knowledge, beliefs and feeling (Duplesis and Roussesus, 1999). Other factors are culture, sub-culture, religion, geographic regions, nationalities, racial and ethnic groups, (Gelder, 2007, Solomon, 2013). Gender, affinity, interests, opinions, activities and pattern of life (Cooley 1999, Solomon 2013).

Personality is the culmination of various traits that determine the type of person one is. It dictates ones' preferred, ways of dealing with issues, lifestyle and consumption pattern, responding to environment in which one lives. One may be personality product oriented who tend to patronize products or services based on the merchandize itself or service oriented consumers who tend to seek relationship with the seller or manufacturer. Personality changes from person to person, time to time and place to place and can greatly influence what they want, and exhibit behaviourin different circumstances like

aggressiveness, dominance and self-confidence (Shett, Mittal, Newman 1999, Engle 1995). Personality is seen as the sum total of the physical, mental, social and emotional characteristics of an individual,It is mostly described as the visible aspect of an individual that can make a lasting impression on others.

Hardly would a consumer be involved in purchasing major household appliances without experiencing cognitive dissonance, ambiguous and conflicting decisions, especially when one is in the habit of buying branded products and happens to hold the idea that unbranded products are inferior. These decisions are usually based on the varieties available, purchasing power of the individual, the materials from which the products are made from and other characteristic.

The buying decision process of consumers (would) often involve problem recognition, information search, alternative evaluation, purchase decision and post purchase decision behaviour. The consumer, then, selects how much effort to exert in satisfying a need. For some purchases, a consumer may go through these stages or skip or even reverse some of the steps (Amari, 2006). Problem recognition is perceiving a difference between a person's idea or needs and actual satisfaction large enough to trigger a decision. These needs are categorized into psychological security/safety, esteem and self- actualization needs (Itar, Gardner, Bernard, Mandeep, Hart, 2013).

Information search may involve memory scan or commercial sources (and) of articles. Communication with friends and relatives: and visiting a store referred to as personal sources and experiential sources respectively. All these lead to consumer evaluation alternatives in order to reach purchase decision (Kalthou, 2004). Shin, Salenger & Snell, (2002) found out that the use of internet to search for information on prices of general household goods gives the strongest predictor of internet purchase intention. Purchase decision or patronage motives are determined by location, convenience, speed of services, merchandise accessibility, prices, merchandise assortment services and sales personnel. Contrary to repetitive household purchase, the purchase of major household appliances is more complex and far reaching in terms of financial performance implications. characteristic and long term consumer satisfaction but even more complicated by lack of knowledge of the product (Howell, 1999).

Consequently, buying decision processes directs the consumer use of resources and behaviours in market choices on products and services to make purchase.

These behaviours if not well guided could became a serious concern to the general welfare of the immediate family. Today, it appears that consumer acquisition of goods and services is being influenced by various problems such as high inflation and economic down turn, high cost of goods and services and priority concerns. These purchases have directly or indirectly shaped the behaviour of the consumer. Availability of income relative to the needs and wants of family among others is a focal concern against which backdrop this study is intended to ascertain the acquisition priority of consumers. The focus in consumer behaviour has made consumers to view from a broader perspective their own habit that they seem to have taken for granted. This study used particular aspect of acquisition of household appliances as a smaller view to illustrate the broad nature and pattern of consumer behaviour which itself is a multifaceted characteristic.

Hence, the broad objective was to determine consumers perception of the influence of personality and knowledge in the acquisition of household appliances. Specifically, the study determined personality factors, evaluation criteria, influence of knowledge, consumer decision making process and consumers perception on personality and knowledge in the acquisition priority of household appliance.

# **MATERIALS AND METHODS**

The research design used for the study is the survey design. Abuja is the administrative nerve of Nigeria and it comprises a representation of people from various states of the federation. The federal secretariat lies between latitude 9.06660 north of the equator and longitude 7.8330 east of the Greenwich meridian. It is located in the central cadastral zone of Garki district. It houses the employee, ministries and parastatals of the Federal Government of Nigeria.All subjects were fairly educated and employed. Therefore it is reasonable to assume that employment and education provided the subjects with the opportunity to acquire knowledge and information form personalities through interaction with counterparts. Both males and females were surveyed as consumers.

Two hundred [200] consumers responded to twenty one [21] items open ended structured questions and twenty eight [28] questions on a five [5] point likert scale. Respondent comprise both males and females who where civil servants, self-employed, married, and reside in the FCT. Convenience sampling was used to collect data.

Subjects responded to a forty nine (49) item questions including a Likert scale. The instrument was formulated and structured into three (3) sections. Section A comprised nine (9) questions that provided background information about the respondents. Section B comprised twelve (12) questions which provided information on the personality (social, financial, psychological) of the consumer on household acquisition; evaluation criteria of consumers on household appliance; financial knowledge before the acquisition of household appliance by consumers; Section C comprised twenty eight (28) item question to provide information about the perception of consumer personality and information in the acquisition of household appliance on a five (5) point Likert scale structured Strongly Agree (SA) - 5 points, Agree (A) - 4 points, Undecided (UD) - 3 points, Disagree (DA) - 2 points and Strongly disagree (SD) - 1 point. The instrument was validated by three (3) professionals in the Subject area. The reliability of the instrument was determined at 0.832 Cronbasch's Alpha.Decision mean on a five points Likert scale was determined at  $\geq$  3.000. Spearman rank correlation, frequencies percentages were adopted for the analysis.

# **RESULTS AND DISCUSSION**

Table 1: Distribution of frequency on the influence of consumer's personality on the acquisition of household appliance.

Influence	Frequency	Percentage	Ranking			
Personality factor of respondent on Household appliance						
Male						
Financial anxiety	84	42%	1			
Social	10	5%	3			
Psychological	04	2%	4			
Function	20	10%	2			
Female						
Financial anxiety	42	21%	1			
Social	04	2%	3			
Psychological	00	0%				
Function	36	18%	2			
Total	200	100%				

The distribution of the influences of consumer personality factor on the acquisition of household appliances showed that financial anxiety is a major influence for the possibility of making errors for both males [42%] and females [21%] in the acquisition of household appliance. This is followed by functionality of the product male [10%] and females [18%]. The reasons for anxiety as stated by both males and females includeto avoid spending beyond their budget; and avoid being cheated by the retailer.

Table 2: Distribution of frequency on the influence of consumer's personality on the acquisition of household appliance.

Influence	Frequency	Percentage	Ranking			
Evaluation criteria of acquisition of household appliance						
Male						
Price	22	11%	2			
Quality	54	27%	1			
Alternatives	00	0%				
Problem recognition	06	3%	4			
Necessity	06	3%	4			
Luxury	16	8%	3			
Female						
Price	16	8%	2			
Quality	40	20%	1			
Alternatives	00	0%				
Problem recognition	06	3%	3			
Necessity	06	3%	3			
Luxury	16	8%	2			
Total	200	100%				

The foremost criteria considered by respondents to evaluate household appliance when acquiring it included quality by [27%] males and [20%] females, price [11%] males and [9%] females; and luxury [8%] by both male and females.

Table 3: Distribution of frequency of the influence of consumer knowledge/financial information on acquisition of household appliance.

Knowledge/Information/Source	Frequency	Percentage			
Have knowledge/Financial Information	ation?				
Male					
Yes	60	30%			
No	56	28%			
Female					
Yes	42	21%			
No	42	21%			
Total	200	100%			
Have pre-purchase information?					
Male					
Yes	60	30%			
No	60	30%			
Female					
Yes	34	17%			
No	46	23%			
Total	200	100%			
Consumer's Sources of Information					
Male					
Personal Sources	62	31%			

Table 3: Distribution of frequency of the influence of consumer knowledge/financial information on acquisition of household appliance. *-continued* 

Knowledge/Information/Source	Frequency	Percentage
External Sources	66	33%
Female		
Personal sources	46	23%
External sources	26	13%
Total	200	100%
Consumer's experiential sources		
Male		
Yes	42	21%
No	40	20%
Female		
Yes	40	20%
No	78	39%
Total	200	100%
Reason for not doing experiential.	°	0
Consumers avoid their ego to be humiliated by store keepers	20	10%
Consumers do not like to window shop	24	12%
Consumers lack time for experiential sources	24	12%
Consumer prefer to do cash and carry	50	25%

Influence of consumer knowledge on acquisition of household appliance indicated that it is higher for males [30%] than females [21%]. Respondentsdonot do research or do pre-purchase information gathering, [30%] males and [17%] female. They rather choose personal sources than experiencial source/visiting stores to acquire information males [29%] females [39%]. Reasons for not doing experiencial source include the following in the order: prefer to do cash and carry, lack time, donot like to do window shopping and to avoid their ego from being humiliated by store keepers.

Table 4: Distribution of frequency on how consumer makes decision on acquisition of household appliance.

-	· · · ·						
Decision	Frequency	Percentage					
Any problem on deciding many alternatives?							
Male							
Yes	26	13%					
No	66	33%					
Female							
Yes	40	20%					
No	68	34%					
Total	200	100%					

Table 4: Distribution of frequency on how consumer makes decision on acquisition of household appliance. <i>-continued</i>							
Decision	Frequency	Percentage					
Consider spouse's comfort on purchase of household appliance							
Male							
Yes	64	32%					
No	46	23%					
Female							
Yes	48	24%					
No	42	21%					
Total	200	100%					
Are consumers' pu	irchase based on on	e spouse idea?					
Male							
Yes	90	45%					
No	26	13%					
Female							
Yes	64	32%					
No	20	10%					
Total	200	100%					
Are consumers' pu	irchase agreed upor	by both spouses?					
Male							
Yes	100	50%					
No	16	8%					
Female							
Yes	68	34%					
No	08	4%					
Total	200	100%					

Majority of respondents donot experience problems when selecting household equipment from many alternatives they claimed that they consider the comfort of their spouses when acquiring household appliance, [32%] of males and [24%] of female. Most of them, males [50%] and females [34%], revealed that household appliance acquisition is based on their spouse idea. Most all respondents acquire household appliance agreed by both spouse males [50%] and females [34%].

Table 5: Respondents perception on the influence of personality and financial knowledge/information in the acquisition of household equipment

S/N	Items	Respo	ondents	6 Cate	egorie	<b>S</b>	ME	STD	RK
		SA	А	U	D	S	AN		
				D	А	D			
1.	Purchase of household appliance were based on long term span and durability.	162	25	7	2	4	4.70	.765	1
2.	Household appliance is purchased based on family need	141	44	6	4	5	4.56	.857	4
3.	Household appliance is purchased due to information provided by a user	82	100	2	14	2	4.23	.861	16

Table 5: Respondents perception on the influence of personality and financial knowledge/information in the acquisition of household equipment *-continued* 

S/N	Items	Resp	ondent	s Cat	egorio	es	ME	STD	RK
		SA	А	U	D	S	AN		
				D	А	D			
4.	Some household appliance bought was based on personal need	117	64	4	12	3	4.40	.908	10
5.	Household appliance is purchased because of necessity	121	53	8	8	10	4.34	1.072	11
6.	Household appliance is purchased in anticipation of a future need	95	60	2	37	5	4.01	1.226	18
7.	It is appropriate to dispose old household appliance before the purchase of new one.	135	50	7	4	4	4.54	.826	5
8.	Household appliance is purchased because they were in vague	91	61	13	22	13	3.98	1.246	19
9.	Some household appliance acquired were gifts.	118	55	6	11	10	4.30	1.098	13
10.	Availability of spear parts informed purchase of household appliance.	42	42	6	62	48	2.84	1.519	24
11.	Curiosity motivate acquisition of household appliance.	138	17	10	33	2	4.28	1.191	15
12.	Normally dispose household appliance in order to acquire new one.	129	25	8	27	12	4.15	1.321	17
13.	Market survey is necessary before the purchase of new appliance.	69	42	8	25	56	3.22	1.674	20
14.	Financial status influences purchase of household appliance.	136	50	6	6	2	4.57	.740	3
15.	Lack of money stalls possession of household appliance.	79	28	6	29	58	3.21	1.731	21
16.	Quality is not to be traded for high cost when purchasing household appliance.	131	46	10	11	2	4.47	.896	8
17.	Possession of household appliance is based on the desired to be recognized.	48	37	14	41	60	2.86	1.595	23
18.	Household appliance acquired were based on the fact that it became necessary to have them	138	46	2	8	6	4.51	.938	7
19.	Household appliance is acquired because the family requested for it.	137	33	2	16	12	4.34	1.204	11
21.	Environmental factors affects possession of household appliance a great deal.	122	50	6	14	8	4.32	1.088	12
22.	Culture influences the type of household appliance owned.	44	34	4	45	73	2.66	1.621	25
23.	Purchase of household appliance is based on the information provided by the media.	133	32	4	19	12	4.28	1.240	15

Table 5: Respondents perception on the influence of personality and financial knowledge/information in the acquisition of household equipment *-continued* 

S/N	Items	Resp	<b>Respondents Categories</b>		ME	STD	RK		
		SA	А	U	D	S	AN		
				D	А	D			
24.	Lack of household appliance is as a result of conflicting desire or influence for other needs.	69	43	4	22	62	3.18	1.711	22
25.	Purchase decision of household appliance is based on manufacturer popularity.	129	38	2	23	8	4.29	1.184	14
26.	No satisfaction is derived from household appliance purchased.	35	12	13	39	111	2.16	1.557	26
27.	Much satisfaction is gained from household appliance purchased.	152	40	2	4	2	4.68	.693	2
28.	Passion for music and comfort motivate one to retain household appliance.	151	26	4	15	4	4.53	.992	6
	Aggregate mean		4.01,	Decisi	on m	ean≥3	3.0000		

Table 5 indicates respondents' perception on the influence of personality and knowledge in the acquisition of household appliance. On the whole, the aggregate decision mean of 4.01 on 28 items tested is higher than the 3.000 decision mean specifically, the perception that the purchasing of domestic equipment is due to long span and durability attracted the highest decision mean response of 4.70. Similarly, those who had much satisfaction from the purchase of household equipment had a decision mean of 4.68.

A third factor that influences respondents' personality and knowledge in the acquisition of household appliance is the statement that household appliance bought was as a result of their financial status with a decision mean of 4.57.

Two factors stood out as consumers inherent traits when they consider the purchase of household appliance. These were financial anxiety and functionality of the appliance. This was indicated by both males and females. It appears they fear making financial errors by spending much money only to discover that the appliance was not functioning well. Wherefore they feel cheated. Duplesis and Rousseu,-(1999), said consumer behavior is influenced by internal characteristics such as demographic and psychographic factors, personality, motivation, knowledge, beliefs, and feelings.

Foremost criteria consumers considered when purchasing household appliance were quality and price which were considered more by males than females. Both males and females seem to have equal desire for luxury as a criteria. Men appear to be more judicious with spending pattern on household appliances than females. Gender, activity, interest, opinion, activities and personal life could influence consumer behavior(Solomon (2013) and Cooley, (1999)

Consumers in this study researched that information or knowledge would influence males more about household acquisition of appliance than it would the females. However, it was noted that both males and females would not go out of their way to research or do pre-purchase information gathering before the purchase of the product. They would rather seek the opinions of other users about the products than make deliberate effort to inquire about the product themselves. That is, they depended on personal sources than engage on experiential sources. Such attitude included: they would rather do cash and carry, they lacked time to do window shopping and, want to avoid their ego from being humiliated by store keepers. It is important to note that time and attitude in the Nigeria market place could contribute to sound priority decision in the acquisition of product. Kalthou, (2004) said experiential sources lead to consumer evaluation alternatives to reach purchase decision.

It appears decision making in the acquisition of household appliance is important to the families of these respondents. They claimed that the comfort of their spouses is important to them. Perhaps this explains why both males and females said that the idea of purchase of household appliance is initiated by their spouses. It seems that family understanding and joint financial budget is strong among these subjects. Buying decision process of consumers often involved problem recognition, information search, alternative evaluation, purchase decision, and post purchase procedures. When a difference between a person's idea or needs and actual satisfaction is large enough to trigger decision then a problem recognition is perceived. These needs are categorized into psychological, security/safety, esteem and selfactualization needs (et al., 2013).

Generally, long span and durability much satisfaction and financial status appear to stand out among other variables that influence consumer perception on the influence of personality and knowledge in their acquisition of household appliance. Overall, it be inferred that consumers understood that durability and satisfaction derived would require money which speaks a great deal about financial capability to acquire household appliance. However, it is worthy to note that it is possible to make good deals and still make an impression. Howell,-(1999), observed that purchase of appliance is more complex and far reaching in terms of financial characteristics and long term satisfaction but even more complex by lack of knowledge of the product.

# CONCLUSION

Psychographic factors and personality characteristics could be responsible for the lack of confidence these consumers face in making sound priority acquisition of household appliance. Though both males and females seems to have similar evaluation criteria for selection of household appliance before purchase, the males appear to be more judicious in their spending for household appliance.

Consumers do not seem to fully integrate their attitude into the complexity of the market dynamics to encourage experiential pre-purchase search before the purchase of the product. Since the market place is complex and dynamic the consumers is expected to make efforts to help themselves by gathering information before a pre-purchase decision that will add value to the money spent.

Needs specified seems to make decision making easier and satisfaction derived than when a purchase or need is not recognized. These consumer seem to know the difference and have established a decision making process that works for them.Overall, personal characteristics and attitudes seems to hinder consumers' perception in making acquisition priority in household appliance. However, their decision making process provides hidden perceived gains and satisfaction in the acquisition of household appliances. It is recommended that Agencies of consumer related activity such as the Standard Organisation of Nigeria, Consumer Protection Council and National Orientation Agency need to provide a paradigm shift from complacency in information orientation of consumer awareness to educate consumers through programs that will change consumer's attitude through awareness of their right and responsibilities. School curriculum from primary, secondary and tertiary institutions need to emphasise consumer education, marketing psychology than it is being done today.

Further research is needed in this area on a wider scope to determine for both educated and noneducated subjects consumer perception personality on sound acquisition of household appliances. This would provide information about the national outlook of Nigerians in order to adjust the Nigeria society and economy for foreign investment.

## REFERENCES

- Amari, A. (2006). Consumer Oriented Catalog Segmentation: Effective Approaches. Decision-Support Systems. 42(3) 1860-1871.
- Cooley, M. (1999). Social Change Technology and Families. United Nations. Division of Social Psychology and Development.
- Duplesis, P.J. and Rousseu, G.G. (1999). *Buyer Behaviour: A Multicultural Approach*, Oxford University Press.
- Engle, J.F. Blackwell, R.D. Miniad, P.W. (1995). Consumer Behaviour. International ed.Dryden.
- Gelder, K. (2007). Subcultures: Cultural, Historical and Social Practice. Routlege Softover ISBN 0-415-37952-0
- Howell, S.C. (1999). The Potential Home, Environment, Home, Technology and Future Aging, *Journal of Experimental Aging Research*.20.285-290.
- Itar, I. Gardner, E.H. Bernard, I. Mandeep, S and Hart, R. (2013) Wellbeing through self-fulfilment: Examining Developmental Aspects of Self Actualisation. *The Human Psychologist*.4.119-182.
- Kalthou, C. (2004). Selecting Meaning: A process approach to Library and Information services, London *Libraries Unlimited ISBN* 1-59158-0943.
- Shett, J. Mittal, B. Newman, B (1999). Consumer Behaviour and Beyond. New York. Harcourt Brace.
- Shin, Y. Serlenga, L. and Snell, A. (2002). Panel Approach to Testing Annually Affects in factor Pricing Models. *Royal economic society*(Annual Conference) pp. 168.
- Solomon, M.R. (2013). Consumer Behaviour: Buying, Having and Being, Delhi, Phi Learning Private Ltd.





# AGRICULTURAL AND BIOLOGICAL SCIENCES

# **EFFECT OF BREWERY WASTE-WATERS ON IDEMILI RIVER**

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# ABSTRACT

The effect of the waste waters from two Breweries located in Onitsha on the Idemili River was investigated for two years. The physico-chemical and microbiological parameters of both the waste waters and the river samples were also examined. Results obtained indicated that the waste waters had higher level of pH, potassium ions, nitrate ions, sulphate ions and BOD<sub>5</sub> than the river sample. Similarly higher values were recorded for outfall sites of river samples than upstream. There was significant difference between the values recorded for the upstream and the outfall site samples of the river at 5% significant level. It was observed that the outfall site sample was richer in microbial population density than the upstream sample. There were higher levels of both physico-chemical and microbiological parameters of the river samples in the rainy season than in the dry season. The waste water had pollutional effect on the Idemili river especially at the outfall sites.

Key words: Brewery, waste water, river, Idemili

# **INTRODUCTION**

Most Nigerian breweries presently use barley malt, sorghum grains, hops, maize grits, *Saccharomycescarlbergensis* (bottom fermenting yeast) and water in brewing lager beer. But in brewing stout, caramelized malt and *Saccharomycescerevisae* (top fermenting yeast) are used in addition to the raw materials listed (Okafor, 1987).

These beverage industries (breweries) utilize large volumes of these raw materials and ultimately discard large volumes of wastes, which are of two types liquid and solid. Liquid effluent (waste water) consists of brewhouse, cellar, bottling hall cooling water and wash residues. It contains soluble and suspended organic compounds, cleaning chemicals, sterilants, yeast (live and dead), acid and alkali. Solid wastes may include spent grains, yeast, filter cake, broken bottles, fibrous residue, malt husks and label fragments (Chukwura, 1995). The liquid effluent (waste water) has high organic loading due to dissolved components and organic acids as well as cleaning and disinfecting agents. The wastewater especially the brewhouse effluent provides an excellent medium for the growth of many micro-organisms which in turn biodegrade it (Chukwura et al., 1998).

In recent years, significant improvements have been reported in wastewater treatment systems or infrastructure for communities especially in developed countries (O'Reily *et al.*, 2012; EPA, 2010). While on site systems can offer economic, societal and environmental benefits, there is an increasing awareness of the particular challenges offered by onsite wastewater treatment systems (Nuga and Mihelcic, 2008).These challenges include a requirement for robust, cost-effective, low maintenance technologies that can achieve the required levels of treatment (Clifford *et al.*, 2010).

One of the two Breweries that discharge their wastewaters into Idemiliriver has waste-stabilization pond for the treatment of her wastewaters and it is named "Life Breweries Co. Ltd, Onitsha while the other, Premier Breweries Plc, Onitsha has no such treatment system. Both Breweries discharge their total liquid effluents into a large canal, "Sakamori gutter" that eventually terminate into an arm of IdemiliRiver. The aim of this study is to determine the effect of these liquid effluents on the Idemili River.

# **MATERIALS AND METHODS**

The sampling stations include; Life Breweries waste stabilization pond, Premier Breweries total liquid effluent point and three points on IdemiliRiver upstream, outfall site and downstream.

The samples were collected with clean plastic containers for physico-chemical analysis and sterilized conical flasks for microbiological analysis.

# Physico – Chemical Analysis

Physical Parameters such as pH was determined by using the Hach Dual colorimeter/pH with standard buffer solution of pH 4.0 and 9.0.Conductivity was determined by using model 16300 conductivity meter from Hach chemical company (1979). Organic Parameters was determined by the standard method of Mara (1975) to determine the BOD<sub>5</sub> of the samples.Inorganic Parameters was determined by a : Spectrophotometer for sulphate, phosphate and potassium while titration method was used for chloride ions.The organisms were grown on solid and liquid media. The solid media used include mainly commercial oxoid preparations of nutrient agar, MacConkey agar, differential reinforced Clostridal agar (DRCA), Sabouraud dextrose agar and Simmon's citrate agar.

In the media prepared for the growth of the bacteria, fungal inhibitor, actidione 0.5mg/ml was added. But for media prepared for the growth of fungi, bacterial inhibitor, streptomycin – penicillin 30 units each/ml of medium was added (Baker and Breach, 1980). The liquid media used include commercial oxoid preparations of litmus milk, peptone water, sugars and nutrient broth were used. Other liquid media include Tryptone water and physiological saline.

Isolation of bacteria and fungi was done by inoculating on the appropriate media with a sterile wire loop and incubated at 28°C, 37°C and 55°C in aerobic, microaerophilic and anaerobic atmospheres. Pure cultures were made for identification of isolates. The Total viable (aerobic and anaerobic) plate count was done by enumeration of total bacteria and fungi by means of spread plate count was carried out for each effluent sample and river sample. Duplicate plates were incubated at 28°C, 37°C, 55°C both aerobically and anaerobically for 24hrs.

Characterization of bacteria isolateswere based on the criteria contained in C.R.C Handbook of Microbiology (1977), Bergey's Manual of Determinative Bacteriology (Buchanan and Gibbons, 1974). Official Method of Analysis (A.O.A.C, 1975) and Medical Microbiological Techniques (Baker and Breach, 1980). The bacteria isolates were distinguished on the basis of morphology and stain reactions, cultural characteristics and biochemical reactions.

Characterization of fungi (Yeast and Mould) was based on the criteria contained in C.R.C Handbook of Microbiology (1973). The fungal isolates were distinguished on the basis of cultural characteristics and biochemical reactions.Statistical analysis was done using T-test analysis as was stipulated by Zar (1984) to differentiate treatment means.

# **RESULTS AND DISCUSSION**

It was observed that seasons had no effect on the appearance of the total liquid effluent but had appreciable effects on the appearance of the river samples. It was also observed that during the dry seasons the upstream remained clear while the outfall site and downstream were cloudy and slightly cloudy respectively. During the wet seasons, samples from the three sites were slightly cloudy, very cloudy and cloudy accordingly. Similarly higher values were recorded for the other parameters –  $BOD_5$ , potassium, chloride, phosphate, nitrate, during the wet seasons than in the dry seasons (Tables 1 and 2). It was observed that the microbial population density at the outfall site was higher than that of the upstream (Tables 3 and 4).

Table 1: The mean values of the physiochemical characteristics of wastewater samples and Idemili River samples during the wet seasons

Source of sample	Appearance	рН	Cond. ųg/ cm	BOD Mg/L	K <sup>+</sup> Mg/L	Chloride Cl <sup>-</sup> Mg/L	Sulphate SO <sub>4</sub> Mg/L	NO - Mg/L	Phos PO <sub>4</sub> Mg/L
Premier	Slightly Cloudy	5.98	176	1360	9.00	13.83	6.00	3.08	4.60
Life	Slightly	7.80	144	1235	6.50	22.13	0.70	12.6	2.40
Idemili US	Slightly Cloudy	6.60	40	450	6.50	17.98	0.20	4.00	4.50
Idemili OFS	Cloudy	6.95	190	1775	1350	31.80	0.57	15.20	6.00
Idemili DS	Cloudy	6.80	140	965	9.50	22.13	0.45	12.00	3.50
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KEY: US = Upstream: OFS = Outfall site: DS = Down Stream

Table 2. The mean values of the physico-chemical characteristics of wastewater samples and Idemili River sample during the dry seasons.

Source of sample	Appearance	рН	Cond. ųg/ cm	BOD Mg/L	K <sup>+</sup> Mg/L	Chloride Cl <sup>-</sup> Mg/L	Sulphate SO <sub>4</sub> <sup>2-</sup>	NO <sub>4</sub> -Mg/L	Phos PO <sub>4</sub> Mg/L
Premier	Slightly Cloudy	5.95	180	1370	6.80	14.00	5.00	4.50	4.50
Life	Slightly Cloudy	7.8	150	1245	5.90	19.00	3.50	10.00	3.50
Idemili US	Slightly Cloudy	6.35	42	450	6.65	19.36	0.40	5.00	5.50
Idemili OFS	Cloudy	6.70	192	1010	13.60	31.80	0.65	15.00	7.00
Idemili DS	Cloudy	6.65	142	645	9.65	22.13	0.55	12.50	4.80

Key: US = Upstream: OFS = Outfall site: DS = Down stream

Table 3: The mean values of the microbiological parameters of waste samples and river samples during the dry seasons

Source Of Sample	TVAB x 104cfu/ml	TVANB x 104cfu/ml	TVAF x 104cfu/ml	TVANF x 104cfu/ml
Premier	40.1	20.5	8.3	6.5
Life	33.0	16.2	4.0	3.0
Idemili US	5.8	3.4	3.1	2.0
Idemili OFS	21.3	10.4	7.3	4.0
Idemili DS	17.3	8.6	4.1	2.5

KEY: TVAB = Total Viable Aerobic Bacteria: TVANB = Total Viable Anaerobic Bacteria:

TVAF = Total Viable Aerobic Fungi:

TVANF = Total Viable Anaerobic Fungi.

Table 4: The mean values of the microbiological parameters of waste samples and river samples during the dry seasons

Source of sample	TVAB x 10 <sup>4</sup> cfu/ml	TVANB x 10 <sup>4</sup> cfu/ml	TVAF x 104cfu/ml	TVANF x 10 <sup>4</sup> cfu/ml
Premier	36.0	21.8	8.8	8.1
Life	34.0	17.9	4.5	6.0
Idemili US	8.0	5.2	3.8	2.5
Idemili OFS	23.1	12.3	8.0	4.7
Idemili DS	17.0	10.4	4.8	3.2

Key: TVAB = Total viable Aerobic Bacteria: TVANB = Total Viable Anaerobic Bacteria: TVAF = Total Viable Aerobic Fungi: TVANF = Total Viable Anaerobic Fungi.

Heterotrophic bacteria isolated include *Bacillus* sp 1 and 2, *Psendomonas* sp 1 and 2, *Staphylococcus* sp 1 and 2, *Peptococcus* sp, *Clostridium* sp 1 and 2, *Lactobaccillus* sp, *Flexibacter* sp, *Micrococcus* sp 1 and 2, *Streptomyces* sp.

Heterotrophic fungi isolated include the genera of (a) mould; *Penicillin, Aspergillus, Rhizopus, Cladosporium and mucor* (b) yeast: *Saccharomyces and Schizosaccharomyces*.

# **RESULTS AND DISCUSSION**

The result revealed that higher values were recorded for the other parameter –  $BOD_5$ , potassium, chloride, phosphate, nitrate, during the wet seasons than in the dry seasons. These could be as a result of the run-offs from the municipal refuse and surrounding farmland by W.H.O (1971) for drinking water. The BOD values recorded for the effluent and outfall sites were well above the recommended values by the US Environmental Protection Agency i.e. 45mg/L

**CONCLUSION** 

as weekly discharge limit (Technobanoglous, 1979). This means that there would be oxygen depletion at the outfall sites, leading to adverse effect on the aquatic life and the growth of microbes. The presence of sulphate reducing bacteria confirms the finding. Its by-product hydrogen sulphide has been reported to be more toxic than cyanide (Gaylarde and Cook, 1990). Death of marine, freshwater and estuarine life due to activities of these organisms has been reported (Postgate, 1984). It was also recognized that these organisms constitute serious health hazards to the workers in the Engineering and Offshore oil industries. (Hamilton, 1983).

The waste waters from the Breweries studied, and the seasonal charges had remarkable pollutional effects on both the microbial load and physico-chemical parameters of Idemili River. There was significant differences between values obtained with upstream and outfall site samples at P<0.05. Similarly, O'Reily *et al.*, (2012) observed that decentralized systems for wastewater do not have permanent operators and indeed, may be infrequently maintained and monitored. Thus, compliance with increasingly stringent regulation can be difficult to achieve.

Hence, adequate treatment must be instituted for the water parameters to meet the standards as recommended by World Health Organization.

# REFERENCES

- A.O.A.C. (1975).Official Methods of Analysis Association of Official Analytical Chemists Washington D.C. Baker, F.J. and Breach, M.R. (1980).Medical Microbiological Techniques.1st edition. Butterworth and Co.
- (Publishers) Limited. Buchanan, R. E. and Ginnons, N.E. (1974).Bergey's Manual of Determinative bacteriology.8th edition.The
  - Williams and Wilkins Company Baltimore.
- Chukwura, E.I. (1995). Microbiological Treatment of Wastewaters from some Nigerian Breweries, Ph.D Thesis, University of Port Harcourt, Nigeria.
- Clifford, E., Nielen, M., Sorenson, K. and Rodgers, M. (2010). Nitrogen dynamics and removal in a horizontal flow biofilm reactors for wastewater treatment. *Water Research*. 44(13): 3819-3828.
- Chukwura, E.I., Okpokwasili, G.C. and Onochie, C.C. (1998). Physicochemical and Microbiological Analysis of brewhouse Effluent. *J. of Appl Sci.* 1: 1 9.
- C.R.C. Handbook of Microbiology (1973).Laskin, A.I and H.A. Lechevaliereds C.R.C Press Inc. West Palm Beach, Florida. Pp: 1 803.
- Environmental Protection Agency (EPA) (2010). Wastewater quality in Ireland; 2007-2009. ISBN: 978-1-84095-387-9. EPA, Johnstown Castle, Republic of Ireland.
- Gaylarde, C. and Cook, P. (1990).New rapid Methods for the Identification of Sulphate Reducing Bacteria Inter. Biodeterioration. 26: 337 – 345.
- Hach Chemical Company, (1979). Products for water and waste-water analysis. Hach Chemical Company, Loveland Colorado, U.S.A.
- Hamilton, W.A. (1983). Sulphate-reducing bacteria in offshore oil industry. Trends in Biotech 1: 36 40.
- Mara, D. (1975). Sewage treatment in hot climate. 1st edition John Wiley and Sons Ltd. Chichester.
- Muga, H.E. and Mihelcic, J.R. (2008).Sustainability of wastewater treatment technologies. *Journal of Environmental Mnagement.* 88(3): 437-447.
- Okafor, N. (1987). Industrial Microbiology, University of Ife, Ile-Ife.
- Postgate, J.R. (1984). The Sulphate Reducing Bacteria. Cambridge University Press, Cambridge.
- O'Reily, E.O., Fox, S., Rodgers, M. and Clifford, E. (2012).Research developments in the on-site treatment of waste water.Publication of the Dep't of Environment, Community and Local Government; Regulatory Impact Analysis, Dublin, Ireland.
- Technobanoglous, G. (1979). Wastewater Engineering Treatment, Disposal and Reuse, McGraw-Hill Inc; New Delh.
- W.H.O. (1971). International Standards for Drinking Water. 3rd ed. World Health Organization, Geneva.
- Zar, J.M. (1984). Biostatistical Analysis.2nd ed. Prentice-Hall.Inc; Englewood Cliffs New Jersey 07632.





AGRICULTURAL AND BIOLOGICAL SCIENCES

# **GROWTH AND ANATOMICAL RESPONSES OF TOMATO** (LYCOPERSICON ESCULENTUM) UNDER MICROGRAVITY AND NORMAL GRAVITY CONDITIONS

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# ABSTRACT

Microgravity is known to be a major abiotic stress in space which affects plants depending on the duration of exposure. In this research, tomato seeds were exposed to long hours of simulated microgravity condition using a one-axis clinostat. The seeds were sown on a 1.5% combination of plant nutrient and agar-agar solidified medium in three Petri dishes. One of the Petri dishes was mounted on the clinostat and allowed to rotate at the speed of 20 rpm for 72 hours while the others were subjected to the normal gravity vector. The anatomical sections of both clinorotated and normal gravity plants were made after 72 hours and observed using a Phase contrast digital microscope. The percentage germination as well as the growth rate of the normal gravity seeds was higher than the clinorotated treatments. The orientation of the clinorotated roots during germination were in different directions unlike the normal gravity which all germinated towards the direction of gravity vector. The clinostat was able to switch off gravistimulation as distinct cellular arrangement was observed for the tomato plants under normal gravity condition unlike those of the clinorotated treatment. The results revealed that the thickness of the epidermis and cortex of the roots of normal gravity are higher than those of clinorotated. This suggests that under long-term microgravity exposure, plants can acclimatize to the stress by changing their internal cellular features such as reduction in the thickness of cells and rate of cell proliferation.

Keywords: anatomy, clinostat, germination, microgravity, Lycopersicon esculentum

# **INTRODUCTION**

Microgravity is a characteristic of space environment, a condition of altered gravity which poses an abiotic stress on an organism's metabolism, growth and development (Jing *et al.*, 2015). Various platforms have been used to simulate microgravity condition. Examples include the dropping tower at the centre for microgravity research in Bremen, Germany, the suborbital flight usually funded by national space agencies across the world and the clinostat. International space station (ISS) which have been used as experimental platforms to conduct research in a true microgravity condition. Several authors have simulated plant's response to the condition of altered gravity (Moore *et al.*, 1987, Fujie *et al.*, 1993, Mirsandi *et al.*, 2015, Jing *et al.*, 2015).

Gravity is a fundamental force that affects everything on Earth according to the relation given by Sir Isaac Newton in equation 1 below.

The clinostat simulate a fraction of Earth gravity when a biological system is subjected to horizontal rotation on it according to the relation given in equation 2

$$g = \frac{R \times (\frac{\pi rev.per minute}{30})^2}{Acceleration due to gravity} \qquad \dots 2$$

Where g = Decimal fraction of Earth gravityPlants grown in microgravity or simulated microgravityexhibit spontaneous auto morphogenesis (changes ingrowth direction) (Zheng*et al.*, 2015) due to changesin plant's hormones such as Auxin, Gibberellins andEthylene which serve as signal transducers respondingto the changes is the gravity vector. Different plantshave unique responses to the changes in gravityvector. Under microgravity conditions in space, thegrowth rates of many plant organs were reported toincrease (Halstead and Dutcher 1987), but they werenot changed or even decreased in some organs (Kiss*et al.*, 1998, Levine*et al.*, 2001).

This study attempts to examine the growth rate and anatomical structure of the root tip of *Lycopersicon esculentum* under a simulated microgravity condition in the laboratory.

# **MATERIALS AND METHODS**

Seeds of tomato (*Lycopersicon esculentum*), accession number NG/MR/MAY/09/066 which was used for this study was collected from the National Centre for Genetic Research and Biotechnology (NACGRAB), Ibadan, Nigeria.

Agar-agar was used as a seed-supporting substrate for germination experiment. The substrate which is transparent for clear observation was prepared according to standard method (UNOOSA, 2013). 100 mL of 1-1.5% Duchefa Biochemie Plant Agar-Agar in tap water (1.5 g agar-agar in 100 mL of tap water) was prepared. The agar-agar was boiled and stirred until no visible particles are left (up to two minutes) to obtain a clear solution. The solution was allowed to cool down to about 60 °C. Three petri dishes were filled with 10 mL to 25 mL of the agar-agar solution. The right depth of the agar-agar solution is such that the seeds can be embedded only halfway in the agar-agar, thus guaranteeing a supply of oxygen for the seeds. The agar-agar is allowed to cool down and solidify.

In each petri dish, nine seeds of the tomato plants were planted on the agar-agar by using the tweezers in the same direction in order to identify the micropyle. After seeding the seeds on the agar-agar surface, two of the petri dishes were placed vertically using a petri dish holder as control and the third petri dish was mounted on the clinostat. The clinostat was rotated at a speed of 20 rpm for 72 hours (3 days) inside a growth chamber. The set-up was isolated from light using a closed chamber keeping all environmental conditions equal for both the clinorotated and the control. The time of germination was recorded and germination percentage was calculated after germination.

After germination, one of the Petri dishes growing on normal gravity condition was rotated through 90 degrees to observe the response of the roots towards gravity vector. The pictures of the 3 Petri dishes i.e. normal gravity (1g), 90 degree rotated and clinorotated was taken at every 30 minutes using a Canon ixus 160 digital camera (20 mega pixel) for 3 hours in order to determine the growth rate and root curvature.

The root curvatures of the 90 degrees turned and clinorotated roots were determined following the standard methods (UNOOSA, 2013). It was done using an open-source image-processing application called ImageJ software. Out of the nine seedlings in each petri dish, three uniformly germinated ones were selected for measurement and analysis at each time point i.e. every 30 minutes for 3 hours. Each result represents an average of three replicates.

The growth rates were determined using standard methods (UNOOSA, 2013). Out of the nine seedlings in each petri dish, three uniformly germinated ones were selected for measurement and analysis measured using ImageJ software.

The anatomical studies commenced after 72 hours, when free-hand fresh transverse sections of the shoot and root of the clinorotated plant and normal gravity plant in water were prepared using a dissecting blade. Two or three drops of 1% Safranin O stain was transferred by pipette to a clean slide. The specimen was then placed by forceps to the drop of stain and left for 1 to 2 minutes. The stain was rinsed with 3 changes of distilled water. Hereafter, the stained specimens were dehydrated using ethanol. This was left for 1 minute and then rinsed with distilled water. The stained specimens were then transferred to a clean slide containing a drop of dilute glycerol and covered with a clean cover slip which is placed gently at an angle to avoid air bubbles. The cover slip was sealed with transparent nail polish. The mounted specimen was hereafter placed on the digital compound microscope for microscopic observation of its anatomical features. All quantitative data were subjected to student's t-test between the normal gravity (control) and clinorotated roots for significance difference.

# **RESULTS AND DISCUSSION**

The seeds of the plant started germinating at 40 hours after planting. All environmental conditions were kept constant for both normal gravity and clinorotated (Table 1). Both the normal gravity and clinorotated seeds started germinating at the same time. However, the percentage germination of normal gravity seeds was found to be (56%) higher than the clinorotated ones (44%). The clinorotated seeds did not germinate in definite pattern. The orientation of the roots was in different directions unlike the normal gravity which all germinated towards the direction of gravity (Fig. 1). The curvature angle of the 90 degree turned roots was far higher than the clinorotated ones at each time point (Fig. 2). The growth rate of the clinorotated roots and that of 1g increased with time after germination (Fig. 3). Also, at each time point after germination, the growth rate of the 1g was higher than clinorotated one.

The orientation of the clinorotated roots which were in different directions showed that the clinorotated roots could not sense gravity in any direction. And since there was no light influence, this could mean that the clinostat was able to create a simulated microgravity condition for the roots of this plant. The 90 degree turned roots were able to sense the direction of gravity thereby leading to increase in their root curvature angle unlike those of clinorotated which were under the influence of microgravity. Also, the higher growth rate observed in the normal gravity roots than the clinorotated could be because the growth hormones responsible for early growth were affected by microgravity. These noticeable differences observed in clinorotated roots could be attributed to the abiotic stress generated as a result of long duration of exposure of the roots to microgravity condition (Zheng et al., 2015). This is similar to Simona et al., (2006) who observed fluctuations in the photosynthetic yield of some plants and attributed them to changes in gravity because series of parameters such as light

intensity, temperature, pH, oxygen concentration, or obstruction of the measurements via air bubbles were kept constant. It also agrees with Tripathy (1996) who observed that photosynthetic functions such as growth rate of wheat plants grown on space stations are affected by the microgravity environment.

It was observed that the normal gravity roots have distinct cellular arrangement unlike those of clinorotated. The roots cells of normal gravity plants developed faster than clinorotated as the boundaries between the cells were noticeable. No root hair was observed on the root of the clinorotated plant. The thickness of the epidermis and cortex of the normal gravity root are higher than that of clinorotated (Table 2). Also, the number of parenchyma cells per millimeter of normal gravity plant was more than the clinorotated one. These observations are in agreement with Zheng et al., (2015) who reported that under long-term (days to months) microgravity exposure, plants acclimatize to the stress by changing their metabolism, internal cellular features such as reduction in the thickness of cells and rate of cell proliferation.

# CONCLUSION

These results conclusively show that microgravity can affect plants at the individual organ, tissue, cellular and sub-cellular levels.

	Normal Gravity	Clinorotated			
Relative Humidity at Planting	64%	64%			
Relative Humidity at Germination	70%	70%			
Temperature at Planting	26.10C	26.10C			
Temperature at Germination	250C	250C			
Percentage germination	56%	44%			

Table 1: The environmental variables and growth conditions of normal gravity and clinorotated seeds

Table 2: The anatomical features of the root ofLycopersicon esculentum

ANATOMICAL FEATURES	CLINOROTATED	NORMAL GRAVITY
Length of root hairs	No root hairs observed	0.09mm - 0.13mm
Thickness of epidermis	$0.01\pm0.0\ mm$	$0.02\pm0.0\ mm$
Thickness of the cortex	$0.30\pm0.04\ mm$	$0.36\pm0.01\ mm$
Diameter of vascular bundle	$0.22 \pm 0.0 \text{ mm}$	$0.24\pm0.0\ mm$
No of cell per mm	$20.0 \pm 2.52 \text{ mm}$	$22.33 \pm 1.67 \text{ mm}$

Value represents mean  $\pm$  SE and are significantly different at  $\alpha \leq 0.05$ 



Fig. 1:(a) 1g *Lycopersicon esculentum* (b) clinorotated *Lycopersicon esculentum* (c) 900 rotated *Lycopersicon esculentum* 



Fig. 2: The average curvature angle of the clinorotated roots and 90 degree turned roots of *Lycopersicon* esculentum



Fig. 3: The effect of clinorotation on the growth gate of *Lycopersicon esculentum* 

# REFERENCES

- Cowls, J. R, Scheld, H. W, Lemay, R., Peterson, C. (1984). Growth and lignifications in seed lings exposed to eight days of microgravity. *Annals of Botany*
- Fujie, M., kuroiwa, H., Suzuki, T, kuroia, T. (1993). Organelle DNA Synthesis in the quiescent centre of Arabidopsis thaliana. (col). J. Exp.Bot. 44, 690-693.
- Hader, D.P, Hemmersbach, R, & Lebert, M. (2005). Gravity and the behaviour of Unicellular organisms. Cambridge University Press Page 14 & 30.

Halstead, T.W. and Dutcher, F. R. (1987). Plants in space. Annual Review of Plant Physiology 38: 317-345.

- Hoson, T (2014). Plant Growth and Morphogenesis under Different Gravity Condition: Relevance to Plant Life in Space. *Life* 4, 205 216; doi:10.3390/life4020205
- Hu, L., Haiying, C., Xianying, D., Jing, J, Weiming, S and Weiming, C. (2015). Proteomic Analysis of the upper and lower flanks of the Base of Rice Shoot in the Gravitropism. *Microgravity Science and Technology*, 27: 403 – 416. Doi: 10.1007/s12217-015-9433-1
- Jing, J. Haiying, C. and Weiming, C. (2015). Transcriptome Analysis of *Oryza sativa Calli* under Microgravity 27; 437 453. Doi 10.1007/s12217-015-9432-2.



Fig. 4: The transverse section of the clinorotated root of *Lycopersicon esculentum* 



Fig. 5: The transverse section of the normal gravity root of *Lycopersicon esculentum* 

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- Kiss, J. Z., Katembe, W. J. and Edelmann, R. E. (1998). Gravitropism and development of wild-type and starch-deficient mutants of Arabidopsis during spaceflight. *Physiology of Plant* 102: 493–502.
- Levine, L. H., Heyenga, A. G., Levine, H. G., Choi, J. W., Davin, L. B., Krikorian, A. D. and Lewis, N. G. (2001). Cell-wall architecture and lignin composition of wheat developed in a environment. *Phytochemistry* 57: 835–846.
- Mirsandi, H., Yamamoto, T., Takagi, Y. Okano, Y., Inatomi, Y., Hayakawa, Y., and Dost, S. (2015). A Numerical study on the growth process of InGaSb Crystal
- Moore, D., and Cogoli, A. (1996). Biological and Medical Research in Space. Springer, ISBN-13:978-3-642-646-942.
- Simona, A. B., Matteo, F. K., Eva, E. S. and Wilken-Jon, V. A. (2006). The Effects of Microgravity on the Photosynthetic Yield of *Nannochloropsis Salina and Spirulina Platensis*. International University Bremen, College Ring 6, 28759 Bremen, Germany.
- Tripathy, B. C., Brown, C. S., Levine, H. C., and Krikorian, A. D. (1996). Growth and Photosynthetic Responses of Wheat Plants Grown in Space. *Plant Physiology* 110: 801- 806, United Nations Office for Outer Space Affairs (UNOOSA) (2013).
- UNOOSA (2013). Teacher's guide to plant experiments in microgravity- Human Space Technology Initiative. United Nations, New York.
- Zheng, H. Q., Han, F., and Le, J. (2015). Higher Plants in Space: Microgravity Perception, Response and Adaptation. *Microgravity Science and Technology*, 27: 377 386. Doi: 10.1007/s12217-015-9428-y





AGRICULTURAL AND BIOLOGICAL SCIENCES

# **GROWTH AND YIELD TRAITS OF GROUNDNUT**(*ARACHIS HYPOGAEA*) LINES TREATED WITH HYDROGEN PEROXIDE.

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# ABSTRACT

The response of some growth and yield traits of four groundnut cultivars, Ms 54-76, ICGV-Sm-42, RmP 12 and Samnut 21 treated with hydrogen peroxide for 24 hours prior to planting was studied using seed treatment of 0%, 0.5%, 1%, 2% and 3% of hydrogen peroxide ( $H_2O_2$ ). The treated seeds were planted in a split plot experimental designing a completely randomised design (CRD) using three replications in University of Calabar, Nigeria. Results showed that more seedlings of Ms 54-76, ICGV-Sm-42 and RmP 12 were established than Samnut 21 at fourteen days after planting. There was a similar variation in the number of days to 50% flowering, number of pods per plant, plant height, number of leaves, number of branches, and weight of pods per plant, shelling percentage and seed weight. The  $H_2O_2$  incited increase in the seed germination, plant height and in seeds weight from 8 weeks after planting upwards. Generally, ICGV-Sm-42 had the most luxuriant growth and superior yield of the four varieties, followed by Sm-54-76 and RmP 12.ICGV-Sm-42 had the highest response to seed treatment with hydrogen peroxide.

Keywords: Hydrogen peroxide; ArachishypogaeaL; physiological stimulant; crop yield; mutagen.

# **INTRODUCTION**

Groundnut (*Arachis hypogaea* L.) is one of the very important grain legumes in the tropical cropping system, especially in Africa, whereit is grown mainly by smallholder farmers. China, India and Nigeria are the leading producers of groundnut in the world (IFST, 1999; FAO/IAEA, 2004). Tweneboah (2000) reported that out of 6 million tonnes of groundnuts produced in Africa, about 80% comes from the savannah zone, south of the Sahara and only 5% from the equivalent zone in the Southern hemisphere. Nigeria, Senegal, Niger and the Sudan are the four largest groundnut producers in Africa.

Groundnut is the 13<sup>th</sup> most important food crop of the world, the 4th most important source of edible oil and 3rd most important source of vegetable protein (Tarawali and Quee, 2014). Groundnut seeds contain high quality edible oil (50%), easily digestible protein (25%) and carbohydrate (20%). It is grown on 26.4 million/ha worldwide with a total production of 36.1 million metric tons, and an average productivity of 1.4 metric tons ha-1 (FAO/IAEA, 2004, Shiyam, 2010, Showemimo *et al.*, 2012, Tarawali and Quee, 2014). In Nigeria, groundnut has lost its position as a crop of prominence due to emphasis shift to the petroleum industry, although, there is a current effort to restore its production.

Recent genetic improvement of groundnut crop cannot be fully exploited because report has it that yield in groundnut has not significantly improved over time and this could be attributed to its narrow genetic base (People and Herridge, 1990 and Suvendu *et al.*, (2007). The narrow genetic base makes it difficult to improve groundnut through conventional breeding programme, but induced mutation breeding has been reported as a means of increasing variability and enhancing crop improvement. Ritambhara and Kumar, (2011), established that mutation is a sure means for the creation of variability among plant population.Mutation have effects on physiological, biochemical, morphological and so on, traits in plants, which can be exploited for the benefit of humans.

Hydrogen peroxide  $(H_2O_2)$  has been reported to promote germination of Zinnia elegans L in the pericarp covering the seed within the fruit in a dose-dependent manner, as well as regulating metabolism in plants (Ślesak et al., 2007). Due to its relative stability and ability to diffuse through membranes, it is able to translocate second messenger triggering Ca<sup>+</sup> fluxes, modify protein and activate gene expression in plants (Vranová et al., 2002). Hydrogen peroxide also regulates plant development, stress adaptation or programmed cell death (PCD). PCD itself is essential for developmental processes and environmental responses, including aleurone cell death, hypersensitive response to pathogens, and allelopathic plant to plant interactions(Gechev and Hille, 2005). These outstanding physiological stimulation attributes of H<sub>2</sub>O<sub>2</sub> had prompted this study. The objective of the study was to evaluate the growth and yield characteristics of some groundnut cultivars after the seeds were treated with hydrogen peroxide for 24 hours before planting.

## MATERIALS AND METHODS

The study on variation induced by hydrogen peroxide  $(H_2O_2)$  in groundnut lines wasconducted at the University of Calabar, Calabar, Nigeria. Calabar (latitude 4.24°N; longitude 7.5°E) situated in the humid rainforest region of southern Nigeria.

The experiment was potted with 100 polyethylene bags filled with soil weighing 11.3kg. The experimental design was a split plot arrangement in a completely randomised design (CRD) with 3 replications. The main plot was the levels of H<sub>2</sub>O<sub>2</sub> (0.5%, 1.0%, 2.0%, 3.0%, and the control, without hydrogen peroxide (0 %), for 24 hours) and the four varieties of groundnut (MS 54-76, ICGV-Sm-42, RmP 12 and Samnut 21) constituted the sub plots.One hundred seeds of each variety were soaked in each concentration of H<sub>2</sub>O<sub>2</sub> and the experiment was placed in the open outside the greenhouse. Datawere collected from the two plants in each bag and analysed using GenStat (2005) statistical tool and the differences between the treatments means were separated using the Least Significant Difference (LSD) at 5% level of probability.

## **RESULTS AND DISCUSSION**

Seedling establishment of the groundnut varieties is presented in Table 1. Ms 54-76, ICGV-Sm-42 and RmP 12 were established earlier than Samnut 21. The number of branches per plant is presented in Table 2. ICGV-Sm-42, RmP 12 and Samnut 21 had significantly more branches per plant than Ms 54-76.

The plant height of the four groundnut varieties submerged in  $H_2O_2$  is presented in Table 3. Two varieties (ICGV-Sm-42 and RmP 12) were significantly taller than the other varieties (Ms 54-76 and Samnut21). At six WAP, the height of ICGV-Sm-42 was not different from that of Ms 54-76 but significantly taller thanRmP 12 and Samnut 21. At 8 weeks after planting (WAP),ICGV-Sm-42 at1%, 2% and3% of  $H_2O_2$ , RmP 12 at 2% and3%, and Ms 54-76 at 2% were not significantly different from each other but were significantly taller than at 0.5 per cent and the control. At ten WAP, ICGV-Sm-42 was as tall as RmP 12 and were significantly taller than Ms 54-76 and Samnut 21.

At two and four WAP, Ms 54-76 and ICGV-Sm-42 had significantly more leaves per plant than RmP 12 and Samnut 21, similar trend was observed at four and six WAP (Table 4 a-c). The number of days to 50% flowering is presented in Table 5. RmP 12 flowered first, followed by Samnut 21, ICGV-Sm-42 and then Ms 54-76.

A similar developmental trendshown in the growth curve was observed in yield traits. Ms 54-*FULafia Journal of Science & Technology Vol. 2 No.1 March, 2016*  76 had significantly more pods than the other three varieties (ICGV-Sm-42, RmP 12 and Samnut 21), ICGV-Sm-42 and Samnut 21 had more pods than RmP 12 (Table 6a). Variation in number of pods per plant is a genetic trait influenced by the environment and has been reported by other researchers (Ahmad and Mohammad,1997 and Virk *et al.*, 2005).Ms 54-76 had heavier pods than ICGV-Sm-42, RmP 12 and Samnut 21 (Table 6b).

The shelling percentage in Ms 54-76 and Samnut 21 was significantly higher than in ICGV-Sm-42 and RmP 12 (Table 6c). Shelling percentage indicates the proportion of the total dry matter attributable to the seeds; it is affected by varietal factors, as well as environmental factors affecting photosynthesis, dry matter partitioning and accumulation. Abdullah *et al.*, (2007) reported ashelling percentage of 48-61%, while Virender and Kandhola, (2007) had reported 536-65% in other groundnut varieties.

Ms 54-76 had the highest seed yield (Table 6d). All the varieties, MSs 54-76, ICGV-Sm-42 and Samnut 21 had higher seed yield than RmP 12. Hydrogen peroxide influenced the weight of 100 seeds in this experiment, from 1 per cent, there was increase in the seed weight than at 0.5 % and the control (Table 6e), especially with respect to the response of Ms 54-76 and ICGV-Sm-42. Farag and Zahran (2014) had similarly observed enhanced vegetative growth and yield traits (leaf area, leaf area index, shelling percentage, number of pods and seeds) in groundnut lines from irradiation with gamma rays. This implies that hydrogen peroxide can induce physiological stimulation that will improve yield in groundnut.

According to Gechev *et al.*, (2005), low doses of  $H_2O_2$  induce stress adaptation to a new climate; such conditions as a new temperature, altitude or environment, in plants. This hypothesis was demonstrated in this study as was evident in changes that created increase in phenotypic expression, such as in height, number of leaves and seed yield in ICGV-Sm-42 and Ms 54-76.These varieties showed better response after seed soaking in hydrogen peroxide.

Table 1.Seedling establishment in groundnut whose seeds were treated with  $H_2O_2$  before planting.

H <sub>2</sub> O <sub>2</sub> Level	Ms 54-76	ICGV-Sm-42	RmP 12	Samnut 21	Mean
0	3.80	4.00	4.00	2.00	3.45
0.5	3.80	4.00	3.60	2.20	3.40
1.0	4.00	4.00	3.80	2.40	3.55
2.0	3.60	4.00	3.80	2.20	3.40
3.0	4.00	4.00	3.00	2.60	3.40
Mean	3.84	4.00	3.64	2.28	

Key: LSD (0.05) for variety = 0.39; LSD for  $H_2O_2$  levels = NS; LSD for variety  $x H_2O_2$  levels = NS

Table 2.Number of branches per plantof groundnut lines treated with  $H_2O_2$  before planting

H <sub>2</sub> O <sub>2</sub> Level	Ms 54-76	ICGV-Sm-42	RmP 12	Samnut 21	Mean
0	4.93	6.63	7.57	6.20	6.33
0.5	5.47	6.80	5.77	6.47	6.12
1.0	5.57	6.80	6.27	6.80	6.36
2.0	5.98	5.50	6.92	5.55	5.99
3.0	6.33	6.73	6.47	6.60	6.53
Mean	5.66	6.49	6.60	6.32	

Key: LSD (0.05) for variety = 0.64; LSD for H2O2 levels = NS; LSD for variety x H2O2 levels =NS

Table 3.Plant height of groundnut linestreated with  $\rm H_2O_2$  before planting.

	a. Plant h	neight at 2 we	eks after	planting	
H <sub>2</sub> O <sub>2</sub> Leve	1	Variety			Mean
	Ms 54-76	ICGV-Sm-42	RmP 12	Samnut 21	
0	5.05	6.24	4.86	2.74	4.72
0.5	4.39	5.88	5.79	4.18	5.06
1.0	4.61	5.96	5.22	3.70	4.87
2.0	5.46	6.36	6.55	3.95	5.58
3.0	4.36	6.18	5.65	4.55	5.18
Mean	4.77	6.12	5.61	3.82	

Key: LSD (0.05) for variety = 0.58; LSD for  $H_2O_2$  levels = NS; LSD for variety x  $H_2O_2$  levels =NS

b. Plant height at 4 weeks after planting.

H <sub>2</sub> O <sub>2</sub> Level	Variety			Mean	
2 2	Ms 54-76	ICGV-Sm-42	RmP 12	Samnut 21	
0	9.89	10.26	9.66	6.93	9.19
0.5	9.05	8.90	11.04	7.18	9.04
1.0	7.71	10.64	9.96	7.19	8.88
2.0	10.12	10.56	11.37	6.76	9.70
3.0	7.75	10.61	11.41	8.10	9.47
Mean	8.90	10.20	10.69	7.23	

Key: LSD (0.05) for variety = 0.82; LSD for  $H_2O_2$  levels = NS; LSD for variety x  $H_2O_2$  levels =NS

c. Plant height at 6 weeks after planting.

H <sub>2</sub> O <sub>2</sub> Level		Variety			Mean
	Ms 54-76	ICGV-Sm-42	RmP 12	Samnut 21	
0	16.00	16.73	13.64	10.95	14.33
0.5	15.21	15.33	14.68	10.63	13.96
1.0	15.04	17.75	13.92	12.07	14.69
2.0	17.25	16.57	14.63	10.47	14.73
3.0	13.06	16.90	14.48	14.43	14.72
Mean	15.31	16.66	14.27	11.71	

*Key: LSD (0.05) for variety = 1.41; LSD for H*<sub>2</sub> $O_2$  *levels = NS; LSD for variety x H*<sub>2</sub> $O_2$ *levels =NS* 

u. Flaint height at o weeks after plainting	d.	Plant height at 8 weeks after planti	ng.
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H <sub>2</sub> O <sub>2</sub> Level		Variety			Mean
	Ms 54-76	ICGV-Sm-42	RmP 12	Samnut 21	
0	18.57	18.45	17.19	14.03	17.06
0.5	17.61	19.52	20.90	13.68	17.93
1.0	16.76	20.93	18.98	14.85	17.88
2.0	19.48	20.35	19.88	12.73	18.11
3.0	15.07	21.11	19.84	16.83	18.21
Mean	17.50	20.07	19.36	14.43	

Key: LSD (0.05) for variety = 2.76; LSD for  $H_2O_2$  levels = NS; LSD for variety x  $H_2O_2$  levels =1.92

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e. Plant height at 10 weeks after planting.							
H <sub>2</sub> O <sub>2</sub> Le	evel	Varie	ty		Mean		
	Ms 54-76	ICGV-Sm-42	RmP 12	Samnut 21			
0	20.43	20.27	20.31	15.47	19.12		
0.5	19.67	20.80	20.83	15.28	19.14		
1.0	18.86	21.99	20.41	16.51	19.44		
2.0	21.68	21.46	21.31	16.06	20.12		
3.0	17.30	21.56	21.31	18.53	19.67		
Mean	19.59	21.21	20.83	16.37			
Kev: LSD (0.	05) for variety = 1.	48: LSD for H_O_ leve	ls = NS: LSD fo	r variety x H <sub>2</sub> O <sub>2</sub> lev	els =NS		

 $tety = 1.48; LSD for H_2O_2$ NS; LSD for var

Table 4.Number of leaves of groundnut varieties whose seeds were treated with H<sub>2</sub>O<sub>2</sub> before planting. a. Number of leaves at 2 weeks after planting.

	u. Humber of foures at 2 weeks after planting.							
H <sub>2</sub> O <sub>2</sub> Level		,	Variety		Mean			
	Ms 54-76	ICGV-Sm-42	RmP 12	Samnut 21				
0	12.62	12.27	6.68	6.20	9.44			
0.5	11.97	11.45	8.03	8.93	10.10			
1.0	12.77	11.95	6.83	9.47	10.25			
2.0	10.10	13.00	9.03	8.93	10.27			
3.0	11.36	11.82	6.90	9.77	9.96			
Mean	11.76	12.10	7.50	8.66				

Key: LSD (0.05) for variety = 1.27; LSD for  $H_2O_2$  levels = NS; LSD for variety  $x H_2O_2$  levels =NS

b. N umber of leaves at 4 weeks after planting.

$H_2O_2$ Level		Variety					
	Ms 54-76	ICGV-Sm-42	RmP 12	Samnut 21			
0	24.39	24.12	20.33	20.50	22.34		
0.5	23.47	24.93	19.70	23.60	22.92		
1.0	26.32	28.80	18.50	22.93	24.14		
2.0	24.07	23.93	20.78	19.55	22.08		
3.0	29.05	29.20	20.61	24.90	25.94		
Mean	25.46	26.20	19.98	22.30			

Key: LSD (0.05) for variety =3.04; LSD for H<sub>2</sub>O, levels = NS; LSD for variety x H<sub>2</sub>O, levels =NS

#### c. Number of leaves at 6 weeks after planting.

$H_2O_2$ Level		Variety					
	Ms 54-76	ICGV-Sm-42	RmP 12	Samnut 21			
0	39.87	38.51	25.68	33.67	34.43		
0.5	33.70	38.00	24.47	38.80	33.74		
1.0	33.75	44.45	26.58	38.33	35.78		
2.0	38.08	39.64	28.20	33.33	34.81		
3.0	35.40	43.87	28.33	48.60	39.05		
Mean	36.16	40.90	26.65	38.55			

Key: LSD (0.05) for variety = 4.83; LSD for  $H_2O_2$  levels = NS; LSD for variety x  $H_2O_2$  levels = NS

Table 5.Number of days to 50% flowering in groundnut cultivars treated with H<sub>2</sub>O<sub>2</sub>.

H <sub>2</sub> O <sub>2</sub> Level	Variety					
	Ms 54-76	ICGV-Sm-42	RmP 12	Samnut 21	Mean	
0	24.80	26.80	30.60	29.60	27.95	
0.5	23.00	27.20	30.40	29.20	27.45	
1.0	24.80	27.60	30.40	28.00	27.70	
2.0	24.80	26.80	30.00	28.00	27.60	
3.0	24.00	26.80	30.00	29.20	27.50	
Mean	24.28	27.04	30.28	28.96		

Key: LSD (0.05) for variety = 0.73; LSD for  $H_2O_2$  levels = NS; LSD for variety x  $H_2O_2$  levels =NS

Table 6. Yield characteristics of groundnut varieties treated with H<sub>2</sub>O<sub>2</sub>before planting.

6	<b>1</b> .	Num	ber	of	pods	per	pl	ant
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H <sub>2</sub> O <sub>2</sub> Level	Variety					
	Ms 54-76	ICGV-Sm-42	RmP 12	Samnut 21		
0	6.43	5.17	5.47	4.30	5.34	
0.5	7.34	5.25	3.16	5.07	5.20	
1.0	6.30	7.03	3.44	5.43	5.55	
2.0	7.93	4.72	4.33	4.50	5.37	
3.0	6.43	5.00	5.93	4.80	5.54	
Mean	6.89	5.43	4.47	4.82		

Key: LSD (0.05) for variety = 0.91; LSD for H<sub>2</sub>O<sub>2</sub>levels = NS; LSD for variety x H<sub>2</sub>O<sub>2</sub>levels =Ns

b. Weight of pods

<u> </u>								
H <sub>2</sub> O <sub>2</sub> Level		Vario	ety		Mean			
	Ms 54-76	ICGV-Sm-42	RmP 12	Samnut 21				
0	7.31	4.48	4.71	5.44	5.49			
0.5	6.15	4.69	3.30	6.03	5.04			
1.0	7.99	8.28	3.18	6.48	6.48			
2.0	9.62	3.97	3.91	5.61	5.78			
3.0	8.65	4.99	4.87	6.23	6.19			
Mean	7.95	5.28	3.99	5.96				

Key: LSD (0.05) for variety = 1.51; LSD for  $H_2O_2$  levels = NS; LSD for variety x  $H_2O_2$  levels = NS c. Shelling percentage.

H <sub>2</sub> O <sub>2</sub> Level	Variety					
	Ms 54-76	ICGV-Sm-42	RmP 12	Samnut 21		
0	75.26	74.03	68.42	74.69	73.10	
0.5	75.09	71.73	67.36	75.85	72.51	
1.0	72.65	76.01	66.98	75.28	72.73	
2.0	74.94	73.12	66.31	74.82	72.30	
3.0	72.69	72.90	63.46	77.60	71.66	
Mean	74.12	73.56	66.51	75.65		

*Key:* LSD (0.05) for variety = 2.07; LSD for  $H_2O_2$  levels = NS; LSD for variety  $xH_2O_2$  levels =NS

#### d. Seed yield per bag

			<u> </u>		
H <sub>2</sub> O <sub>2</sub> Level	l Variety				
	Ms 54-76	ICGV-Sm-42	RmP 12	Samnut 21	
0	5.48	3.31	3.21	3.92	3.98
0.5	4.66	3.48	2.24	4.62	3w.75
1.0	5.78	6.31	2.16	4.83	4.77
2.0	7.23	2.88	2.59	4.19	4.22
3.0	6.25	3.64	3.12	4.80	4.45
Mean	5.88	3.92	2.66	4.47	

*Key:* LSD (0.05) for variety = 1.10; LSD for  $H_2O_2$  levels = NS; LSD for variety  $x H_2O_2$  levels = NS

#### e. Weight of 100 seeds

H <sub>2</sub> O <sub>2</sub> Level		Mean			
	Ms 54-76	ICGV-Sm-42	RmP 12	Samnut 21	
0	48.6	44.4	41.0	52.0	46.5
0.5	40.0	40.4	46.4	48.4	43.8
1.0	60.4	50.2	44.6	46.6	50.5
2.0	52.6	43.4	44.6	55.6	49.1
3.0	54.0	48.0	39.2	53.6	48.7
Mean	51.1	45.3	43.2	51.2	

Key: LSD (0.05) for variety = 0.32; LSD for  $H_2O_2$  levels = 0.32; LSD for variety x  $H_2O_2$  levels = 0.68

## REFERENCES

- Abdullah T, A. A. Rahmianna, S. Hardaningsih. and F. Rozi. (2007). Increasing groundnut yield on dry land AlfisolsinIndonesia. *Journal of SAT Agricultural Research*, 5: 21 29
- Ahmad, N. and R. Mohammad.(1997). Evaluation of promising groundnut (*Arachishypogaea*) varieties for yield and other characters. *Crop and Soil Science Journal*, 2: 48 51.
- FAO/IAEA (2004). http://www.infocris.iaca.org.
- Farag, I.A. A. and A. A.Zahran.(2014) Groundnut (ArachishypogaeaL) growth and yield responses to seed irradiation and mineral fertilization. *IOSR Journal of Agriculture and Veterinary Science*, 7: 63-70
- Gechev, T. S., I., Minkov. and Hille J. (2005) Hydrogen Peroxide-induced Cell Death in Arabidopsis: *Transcriptional and Mutant Analysis Reveals a Role of an Oxoglutarate-dependent Dioxygenase Gene in the Cell Death Process. Life*, 57: 181–188,
- Gechev, T., and Hille J. (2005) Hydrogen peroxide as a signal controlling plant programmed cell death. *Journal Cell Biology*, 168, 17–20.
- GenStat (2005) *GenStat Release* 8.1 Copyright (2005), Lawes Agricultural Trust (Rothamsted Experimental Station)
- IFST (1999). Institute of food science and technology. *The use of irradiation for food quality and safety*'. Institute Of Food Science and Technology, United Kingdom.
- Peoples, M. B., Herridge D. F. (1990).Nitrogen fixation by legumes in tropical and sub-tropical agriculture. *Advances in Agronomy*, 44:155-223.
- Ritambhara, S.and Kumar G. (2011). Comparative effect of x-rays and Laser Beam on the Genetic Architecture of Lathyrus Sativus L. *International Journal of Genetics*, 1:1-4.
- Shiyam, J. O. (2010). Growth and yield response of groundnut (*Arachis hypogaea* L.) to plant densities and phosphorus on ultisol in southern Nigeria. *Libyan Agricultural Research Center Journal International*, 4, 211-214.
- Showemimo, F. A., Asare-Bediako E. A., Abdulai I., Adewusi K. M. and Aderinola A.P. (2012), Genotypic expression of some groundnut varieties to gamma radiation. *In: Proceedings of 36th Annual Conference Genetics in quest for Sustainable Agricultural Transformation* (Pp. 140-143). University of Calabar, 15th-18th October, 2012.
- Ślesak, I., . Libik M, Karpinska B., S. Karpinski and Miszalski Z.. (2007). The role of hydrogen peroxide in regulation of plant metabolism and cellular signalling in response to environmental stresses. *Acta Biochemical Polutant*. 54:39-50
- Tarawali, A. and Quee D. D. (2014) Performance of groundnut (*Arachis hypogaea* L) varieties in two agro– ecologies in Sierra Leone. *African Journal of Agricultural Research*, 9: 1442 – 1448.
- Suvendu, M., Badigannavar A. M., Kale D. M. and Murty G. S. (2007). Induction of genetic variability in disease resistance groundnut breeding line.*BARC Newsletter*, 285:237-247.
- Tweneboah, C. K. (2000). Modern agriculture in the tropics with special reference to Ghana. Publisher CP wood. Pp. 189-190.
- Virender, S. and Kandhola S. S. (2007). Productivity of semi-spreading and bunch type varieties of groundnut as influenced by sowing dates. *Journal of SAT Agricultural Research*, 5: 23 28
- Virk, A. S., Kaul J. N, Bhangoo . S. and Singh A. (2005). Influence of planting techniques and plant population on Biology and pod productivity of summer groundnut varieties. *Research on Crops, 6: 173-174*.
- Vranová, E., Inzé D., Breusegem F. V. (2002). Signal transduction during oxidative stress. *Journal Exp. Botany*, 53:1227-1236.





AGRICULTURAL AND BIOLOGICAL SCIENCES

## ISOLATION AND IDENTIFICATION OF LIPASE PRODUCING FUNGI FROM THE SOIL ENVIRONMENT OF KEFFI METROPOLIS

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## ABSTRACT

An investigation was carried out to isolate, identify and screen for lipase producing fungal species present in the soil environment of Keffi metropolis. Soil samples of approximately 200g each were randomly collected from ten different locations within the Keffi metropolis for the investigation. Sabouraud Dextrose Agar was used for the isolation of the fungal species by pour plate method using Direct Soil Inoculation technique. Five fungal species, Acremonium spp, Mucorsp, Rhizopus stolonifer, Aspergillus niger and Aspergillus flavus were isolated and screened for their ability to produce lipases on tween-20 and phenol red agar. The results of lipase production on tween-20 and phenol red after 5 days of incubation showed that all the isolates were positive for lipase production which was indicated by diameter zone of clearance and visible precipitate of calcium monolaurate due to the deposition of calcium crystal. The diameter of the zone of clearance of the various isolates revealed that *Rhizopus stolonifer* had the highest lipase producing ability (having a diameter zone of clearance of  $12 \pm 0.04$  mm), followed by Aspergillus niger (having  $10 \pm 0.02$  mm). Acremonium sp. and *Mucor* sp. had  $8 \pm 0.07$  mm respectively, while *Aspergillus flavus* was able to produce just a minimal amount of lipases indicated by its zone of clearance ( $6 \pm 0.04$ mm). These results demonstrate the presence of lipase producing fungi in the soil environment of Keffi metropolis, Nasarawa State, and these can be explored locally for the production of the enzyme which is of value commercially in the production of detergents, and also as constituents of some special diets and pharmaceuticals.

Keywords: Lipase production, soil, fungi, Keffi

## **INTRODUCTION**

Enzymes are biocatalyst produced by living cells, and they catalyze specific reactions inside or outside the cells (Spiegel *et al*, 1996).Lipases are a categorized under lipolytic enzymes. Lipolytic enzymes are grouped into three main groups namely; esterases, phospholipases, and lipases (Arpigny and Jaeger, 1999). Lipases (triacylglycerolacyl hydrolases, EC3.1.1.3) are class of enzymes which catalyze the hydrolysis of long-chain triglycerides (Savitha *et al.*, 2007).Sharma *et al.*, (2001) reported that lipases do catalyze hydrolysis of long chain acyl glycerols at an oil-water interface.

Lipases were first discovered in 1856 by Claude Bernard, when he studied the role of the pancreas in fat digestion (Peterson and Drablos, 1994). Since then different lipases have been identified in and isolated from bacteria, fungi, plants and animals. Microbial lipases are found to be more useful than those derived from plants and animals, since they have great variety of catalytic activities, and microorganisms are easy to manipulate genetically and capable of rapid growth on in-expensive media. Furthermore, microorganisms are less affected by seasonal fluctuations and as such, they can be multiplied regularly, and high amount of lipases may be obtained from the microbial cells (Iftikhar et al., 2007; Hills and Degussa, 2003; Hellen and Oliveira, 2009). Microbial lipases, especially fungi lipases are more portent and stable than their plant and animal derivatives (Abdel-Fattah and Ibstisam, 2007). Most identified fungi produced their enzymes extracellularly and their production is easier and safer for industrial and research application (Schimid and Verger, 1998).

The production of lipases by microorganisms is apparently important from the economic and industrial stand point. Fungi are the most important enzyme producers, since their enzymes are produced extracellularly which facilitates their extraction from fermentation media (Arnold, *et al.*, 1975; Ferreira-Costa and Peralta, 1999). Filamentous fungi, especially those of the genera *Rhizopus, Mucor*; *Geotrichum, Aspergillus, Fusarium and Penicillium* are widely used as sources of lipases.

Lipases have enjoyed a wide range of application; their value cannot be underestimated in pharmacy, food industries, detergent, and leather industries among others.Lipases are important enzymes, which have wide range of application due to their advantage in enzymatic hydrolysis over chemical processes. Enzymatic hydrolysis involves less energy and a resultant higher quality of the derived product (Pratyoosh and Kshitiz, 2007). Lipases are used in different areas or industries, such as diary, food, leather industries, and production of

cosmetics, pesticides, and pharmaceuticals (Shahani, 1975; Odera and Joh, 1986; Abd-alla, 1999). With the rapid development of enzyme technology application, lipases have become important in the Oleochemical industries, paper manufacturing, organic chemical processing, biosurfactant synthesis and agrochemical industries (Vulfson, 1994; Hiol *et al.*, 2000). Lipases have also found applications in waste management and also improvement of tanning techniques (Pandey *et al.*, 1999).Jaeger and Eggert (2002) reported that lipases constitute the most important group of biocatalysts for biotechnological applications.

The aim of this study is the screening for lipases producing fungi in the soil environment of Keffi metropolis, Nasarawa State, Nigeria.

## MATERIALS AND METHODS

This study was carried out on the soil environment of Keffi metropolis. Keffi metropolis is the headquarters of Keffi Local Government, Nasarawa State, Nigeria. Keffi is about 68 km away from Abuja, the Federal Capital of Nigeria, and 128 km from Lafia, the capital city of Nasarawa State. It is located on latitude 805'N and longitude 7°50'E, and is situated on an altitude 850 meters above sea level (Akwa *et al.*, 2007). Keffi metropolis is North-West of Lafia, the capital of Nasarawa State, Nigeria.

Soil samples of about 200 g were collected by random sampling from ten (10) different locations namely; High-court, Township Stadium, AngwaNepa, KofanGoriya, Dadin Kowa, Kofar Hausa, G.R.A., Main Campus, Cross-3 and AngwaLambu. The samples were collected with the aid of a sterile hand trowel (which was pretreated with 70% alcohol) at the depth of 4 inches below the surface of the soil. The samples were collected into polythene bags and conveyed to Microbiology Laboratory of Nasarawa State University, Keffi, for analyses.

Certain physico-chemical properties of the soil, viz; soil type, soil pH and temperature were determined as discussed below. The soil types were determined with the aid of a sieve apparatus by sieve analysis using the Unified Soil Classification System (Whitbread *et al.*, 1996).

The pH of the soil samples was determined by the use of a digital pH meter by standard method (AOAC, 1990). A sample of 3g of soil from each site was diluted into 3ml of distilled water and stirred for 5 minutes. The electrode of the pH meter was then inserted into the mixture and readings were taken. An average of three consecutive readings was recorded.

The soil temperature of the various sites was determined using a soil thermometer. The thermometer was inserted into the soil at the depth of 5cm and allowed to stand for 5 minutes, after *FULafia Journal of Science & Technology Vol. 2 No.1 March, 2016*  which temperature readings were taken. Like the pH, average of triplicate readings was recorded for each site or location (Dix and Webster , 1995).

The soil fungi were isolated by direct soil inoculation or soil plate method using pour plate technique as adopted by Makut and Ade-Ibijola (2012). Soil sample of 0.1g of from each site was placed in a more or less even distribution onto the bottom of a sterile Petri dish to which molten/cooled  $(40 - 45^{\circ}C)$ agar was poured and then allowed to set. The plates were incubated at 30°C for 5 days. Colonies were counted after 24 hours and thereafter distinct colonies were sub-cultured within 3-5 days in order to obtain pure cultures of the organisms. The medium used for the isolation is Sabroud Dextrose Agar (SDA) which was incorporated with antibiotics (Ampicillin and Tetracycline), 30mg/liter, to inhibit bacterial contaminants. Fungal isolates from pure cultures were identified based on their macroscopic (cultural) and microscopic (morphological) features with reference to David and Roland (2003).

Phenol red agar plates were also prepared using the method described by Singh et al., (2006). The medium was made up of the following; phenol red 0.01% (w/v), along with 1% (v/v) olive oil, 0.1%(w/v) CaCl<sub>2</sub>, 2% (w/v) agar, and the pH adjusted to 7.4. 20ml of the medium were poured into Petri dishes (after sterilization) and organisms inoculated. The plates were incubated the temperature of 37°C. A change in the color of the phenol red was an indication of the activity of lipase produced by the organisms. The zone of clearance diameter of each isolate indicates the amount of lipase produced by the isolate. The various fungal isolates were screened for lipase production using a chemically defined medium (Tween-80 agar) as described by Gonipath et al., (2005). The medium contained peptone 15g, sodium chloride (NaCl) 5g, calcium chloride (CaCl<sub>2</sub>) 1g, Tween-80, 10ml and agar 15g, all dissolved into 1litre of distilled water. The pH was adjusted to 6.0 using 1M NaOH. About 20ml of the medium was dispensed into Petri dishes and allowed to set. The fungal isolates were inoculated onto the plates and incubated at the temperature of 28°C for 48 hours. The appearance of a zone of clearance around the colonies and visible precipitate of calcium monolaurate was used as an indication of lipase production by the isolates.

#### **RESULTS AND DISCUSSION**

The results of the physico-chemical properties of soil samples of the different locations in Keffi Metropolis are presented in Table 1, while Table 2 shows the results of the the cultural features of the funfi isolated, Table 3 shows the results of the Total Fungal Counts in the soil samples of the different locations. The percentage frequencies of occurrence of fungal isolates are presented in Table 4, while the results of lipases production by the fungal isolates are presented in Table 5.

The anlyses of the soil types of Keffi demonstrated that the soils in High Court and Angwa NEPA are sandy Loam. They both have partly sandy and Loamy particles mixed in an even proportion. The soils from Kopan Goriya, Dadin Kowa, Kofar Hausa and Main Campus were sandy, while those of Angwa lambu and GRA were loamy. However, the remaining locations (Township Stadium and Cross -3) had clay soils. The Results of pH values indicated that Cross -3 had the most acidic pH among all the sites tested with pH of 6.0 while Angwa Lambu had the most alkaline pH of 8.3, followed by Kofar Hausa which has the pH of 8.0. High court, Township Stadium and Kopan Goriya have a slightly alkaline pH with the values of 7.6, 7.7 and 7.4 respectively. The soil of Angwa NEPA and Dadin Kowa have a pH of 7.3 which is near neutral. The temperature of the soil environment of Keffi as at the time of this investigation revealed that the soil environment of Keffi had temperature range from 23 – 31°C. Kofar Hausa and Dadin Kowa have the highest temperature with the values 31°C and 30°C respectively, followed by Township Stadium, Main Campus, and Cross-3 with 28°C respectively. Angwa Lambu had the temperature of 27oC, while Angwa NEPA and GRA have 24oC respectively and High court had the lowest temperature of 23°C. The soil type, pH, and temperature values obtained in this investigation are similar to those obtained in previous studies (Makut and Godiya, 2010; Makut and Owolewa, 2011).

The cultural characteristics of the isolates on Sabouraud Dextrose Agar plates revealed that Acremonium sp. appeared white to cream on the surface and the reverse side was yellow, Mucor sp. appeared fluffy black on the surface while the reverse side shows white tan. Similarly, Rhizopus stolonifer appeared Grayish white on the surface, showing white tan on the reverse side, Aspergillus niger appeared blackish brown on the surface, while the reverse side shows yellow and Aspergillus flavus shows a velvety green color on the surface with reverse showing white. The colors were a key factor in the cultural identification of the fungal isolate, and these were compared with reference to the Mycology Library prepared by David and Rothman (2003). Total fungal count (TFC/g) of the isolates in the various locations showed that the highest count of  $3.0 \times 10^2 \pm 0.03$  was obtained in the soil of Township Stadium, followed by Angwa NEPA which had count of 2.1 x  $10^2 \pm 0.05$ , then Kofar Hausa, GRA and Coss-3 having the counts of 2.0 x  $10^{2}\pm0.04$  respectively. High Court FULafia Journal of Science & Technology Vol. 2 No.1 March, 2016

and Dadin Kowa have counts of  $1.5 \times 10^2 \pm 0.05$  each, Angwa Lambu had 1.4 x  $10^{2}\pm0.05$ , while Kopan Goriva and Main Campus have Total Fungal Counts of 1.0 x  $10^2 \pm 0.04$  respectively. *Rhizopus stolonifer* had the highest percentage of occurrence of 100%. This indicates that Rhizopus stolonifer was present in all the soil samples that were analyzed. The next to Rhizopus was Acremonium sp with a percentage of 50% (indicating that Acremonium sp appeared at least in five locations), followed by Aspergillus flavus with a percentage occurrence of 40%, which also shows that Aspergillus flavus appeared in at least four locations. Aspergillus niger and Mucorsphad percentage occurrence of 30 and 20% respectively. The fungal organisms isolated were identical to those earlier reported by Makut and Godiya (2010); Makut and Owolewa (2011) and Makut and Ade-Ibijola (2012)

The six fungal species isolated were found to produce varying levels lipase The appearance of a zone of clearance and visible precipitate as a result of deposition of calcium crystal was used as an indicator for lipase production. The diameter of the zone of clearance of the various isolates revealed that *Rhizopus stolonifer* had the highest ( $12 \pm 0.05$  mm), followed by *Aspergillus niger* ( $10 \pm 0.05$  mm), and then *Acremonium* sp. and *Mucorsp*. Which had  $8 \pm$ 0.05 mm, respectively.*Aspergillus flavus* had the least diameter zone of clearance ( $6 \pm 0.05$ ). The variation in enzyme production could be attributable to species differences.

The enormous uses of lipases in various industries cannot be over emphasized and it is on the increase in several areas of applications. According to Davranov (1994), extensive and persistent screening for new microorganisms and their lipolytic enzyme will open new, simple routes for synthetic processes and consequently new and faster ways to the applications of lipases in adding value to human life including solving environmental problems.

 Table 1:Physico-chemical properties of soil samples from

 different locations in Keffi

Sites	Soil Type	pН	Temperature (oC)			
High – Court	Sandy – loamy	$7.6\pm0.00$	$23\pm2.43$			
Township Stadium	Clay	$7.5\pm0.00$	$28\pm1.64$			
Angwa NEPA	Sandy – loamy	$7.3\pm0.00$	$24\pm0.83$			
KopanGoriya	Sandy	$7.4\pm0.00$	$30 \pm 1.64$			
Dadin Kowa	Sandy	$7.3\pm0.00$	$30 \pm 0.83$			
Kofar Hausa	Sandy	$8.0\pm0.00$	$31 \pm 1.64$			
G. R. A.	Loamy	$6.7\pm0.00$	$24\pm0.83$			
Main Campus	Sandy	$6.7\pm0.00$	$28 \pm 2.43$			
Cross – 3	Clay	$6.5\pm0.00$	$28 \pm 1.64$			
AngwaLambu	Loamy	$8.3\pm0.00$	$27 \pm 1.64$			

**Table 2.**Cultural characteristics of fungal isolates onSabroud Dextrose Agar

Isolates	Top Color	Reverse Color
Acremonium sp.	White - Cream	Yellow
Mucor sp.	Fluffy – Black	White Tan
Rhizopus stolonifer	Grayis - white	White Tan
Aspergillus niger	Blakish – Brown	Yellow
Aspergillus flavus	Velvety – Green	White

 Table 3.Total Fungal Counts (TFC/g) in soil the different locations of Keffi

Sites	Total fungal Counts (CFU/g)
High – Court	1.5 x 102± 0.05
Township Stadium	3.0 x 102± 0.03
Angwa NEPA	2.1 x 1020.±0.05
KopanGoriya	$1.0 \ge 102 \pm 0.04$
Dadin Kowa	1.5 x 102± 0.05
Kofar Hausa	$2.0 \ge 102 \pm 0.04$
G.R.A	$2.0 \ge 102 \pm 0.04$
Main Campus	$1.0 \ge 102 \pm 0.04$
Cross – 3	$2.0 \text{ x } 102. \pm 0.04$
AngwaLambu	1.4 x 102± 0.05

 Table 4.Percentage occurrence of fungal isolates in the soil of the different locations

					S	ites					Occurrence
Fungal Isolates	A	В	С	D	E	F	G	Н	I	J	(%)
Acremonium sp.	+	+	-	-	-	-	+	-	+	+	50
Mucor sp.	-	-	+	-	-	+	-	-	-	-	20
Rhizopusstolonifer	+	+	+	+	+	+	+	+	+	+	100
Aspergillus niger	-	+	-	-	-	-	+	-	+	-	30
Aspergillus flavus	-	+	-	+	+	-	-	-	+	+	50

**KEY:**(-) = Absent; (+) = Present; A = High Court; B = Township Stadium; C = Angwan; NEPA; D = KopanGoriya; E = Dadin Kowa; F =Kofar Hausa; G = GRA; H = Main; Campus; I = Cross -3; J = AngwaLambu.

Fungal Isolates	Zone of Clearance (mm)					
Acremonium sp.	$8 \pm 0.05$					
Mucor sp.	$8 \pm 0.07$					
Rhizopusstolonifer	$12 \pm 0.04$					
Aspergillus niger	$10 \pm 0.02$					
Aspergillus flavus	6 ± 0.04					

 Table 5:Lipases production by isolates

## CONCLUSION

It is evident that all the fungal species that were isolates in this investigation were found to produce lipases. *Rizopus stolonifer* had the highest lipases activity in terms the diameter zone of clearance formed. Further studies based on the results of this investigation may lead to the use of high lipases producing fungi in industries as well as waste management.

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## REFERENCES

Abd-alla, M.S. (1999) Induced formation of lipase by Aspergillus niger. Journal of Agricultural Science, 7: 31-45.

- Akwa, V.L., Binbol, N.L., Samaila, K.L. and Marcus, N.D. (2007).Geographical perspective of Nasarawa State. Onaivi Printing and Publishing Company Ltd, Keffi, Nigeria. 3p.
- AOAC, (1990).Official method of analysis (5th Ed).Association of Official Analytical Chemists, Washington D. C. Pp.1-10.
- Arnold, G.R., Shahanl, K.M. and B.K. Dwivedi.(1975). Application of lipolytic enzyme to flavor development in dairy products. *Journal of Dairy Science*, 58: 1127-1133.
- Arpigny, J.L. and Jaeger, K.E. (1999). Bacteria lipolytic enzymes: classification and Properties. *Biochemistry Journal*, 343:177-183.
- Davranov, K. .(1994). Microbial lipases in biotechnology. Applied Biochemistry and Microbiology, 30: 427-432.
- David, E. and Roland, H. (2003). The Geraldine Kamiski Mycology Library. Dr. Fungus
- Coporations.w.w.dr.fungus.com.
- Dix N.J. and Webster J.W. (1995). Fungal Ecology. Chapman and Hall. London, U.K. pp. 45-48.
- Ferreira-Costa M.A. and Peralta R.M. (1999) Production of lipase by soil fungi and partial characterization lipase from a selected strain (Penicilliumwortmanii). *Journal of Basic Microbiology*, 39: 11-15.
- Gopinath, S.C.B., Anbu, P. and Hilda, A. (2005). Extracellular enzymatic activity in fungi isolated from oil rich environments. The Mycological Society of japan and springer verlag Tokyo. *Mycoscience*, 46: 119-126.
- Hellen, T. and Oliveria, D.D. (2009). A review on microbial lipase production. *Food Bioprocess Technology*, 1935-5130.
- Hills, G and Degussa, A.G.(2003). Industrial use of lipases to produce fatty acid esters. *European Journal of Lipid Science and Technology*, 105: 601–607.
- Hiol, A., Jonzo, M.D., Rugani, N., Drueti, D., Sandra, L. and Comeau, L.C. (2000). Purification and characterization of an extracellular lipase from thermophilic *Rhizopusoryzae* strain isolated from pal fruit. *Enzyme Microbial Technology*,26:421-430.
- Iftikhar, T., Niaz, M., Zia, M.A., Quadeer, M.A., Abbas, S.Q., Rajoka, M.I. and Haq, I.U. (2007). Screening of media and kinetic studies for the production of lipase from a mutant strain of *Rhizopusoligosporus*. Biotechnological Symposium."Which biotechnologies for South countries".*Proceedings of Biotech World*, 2007.Oran Algerie.
- Jaeger, K.E. and T. Eggert (2002). Lipases for biotechnology. Current Opinion in Biotechnology, 13: 390-397.
- Makut, M.D. and Ade-Ibijola, O.B. (2012). Citric acid producing fungi found in the soil environment of Keffi metropolis, Nasarawa State, Nigeria. *International Research Journal of Microbiology*, 3(7): 240-245.
- Makut, M.D. and Godiya, E. M. (2010). A survey of cellulolytic mesophylic fungi in the soil environment of Keffi metropolis, Nasarawa State, Nigeria. *African Journal of Microbiology Research*, 4 (21): 2191-2195.
- Makut, M.D. and Owolewa, O.A. (2011). Antibiotic producing fungi in the soil environment of Keffi metropolis, Nasarawa State, Nigeria. *Trakia Journal of Science*, 9(2): 33-39.
- Odera, M.T. and Joh, (1986). Molecular cloning of lipase genes from Alcaligenesandtheir expression in *Escherichia coli. Journal of Fermentation Technology*, 64: 363-371.
- Pandey, A., Benjamin, S., Soccol, C.R., Nigan, P., Krieger, N. and Soccol, V.T. (1999). The ream of microbial lipase in biotechnology. *Biotechnology and Applied Biochemistry*, 29: 119-231.
- Peterson, S.B. and Drablos, F. (1994). A sequence analysis of lipases, esterases and related proteins. Cambridge University Press, Cambridge.
- Pratyoosh, S. and Kshitiz, G. (2007). Ecological screening for lipolytic molds and process optimization for lipase production from *Rhizopusoryzae* KG-5. *Journal of Applied Sciences in Environmental Sanitation*, 2 (2): 35-42.

- Savitha, J., Srividya, S., Jagat, R., Payal, P., Priyanki, S., Rashmi, G.W., Roshini, K.T. and Shantala, Y.M. (2007). Identification of potential fungal strain(s) for the production of inducible, extracellular and alkalophilic lipase. *African Journal of Biotechnology*, 6(5): 564 – 568.
- Schmid, R.D. and Verger, R. (1998). Lipase: Interfacial Enzymes with Attractive Supplications. Angewande Chemie International Edition, 37:1608-1633.
- Shahani, K.M. (1975). Enzymes in Food Processing. Academic Press, New York, pp: 188.
- Sharma, R., Y. Chisti and Banerjee, U.C. (2001). Production, purification, characterization and application of lipases. *Biotechnology Advances*, 19: 627 662.
- Singh, R., Gupta, N., Goswami, V.K., and Gupta, R. (2006). A simple activity staining protocol for lipases and esterases. *Applied Microbial Biotechnology*, 70: 679-682.
- Spiegel, S., Foster, D. and Kolensick.(1996). Signal transduction through lipid second messenger.Current Opinion in Biology,8(2): 159 67.
- Vulfson, E.N. (1994). Industrial application of lipases. In: Wolley and Smith (1994)., Lipases, their structure, biochemistry application. Cambridge University Press, Cambridge.
- Whitbread, A.M., Lefroy, R.D.B. and Blair, G.J. (1996). Changes in physical properties and soil organic fractions with a cropping on a red brown earth soil. Australian *Journal of Agronomy*, 12: 23-29.





# AGRICULTURAL AND BIOLOGICAL SCIENCES

## MICROBIAL EXAMINATION OF RAW MILK SOLD IN GARIKI, OKIGWE, IMO STATE, NIGERIA.

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#### ABSTRACT

This study investigated the microbial quality of raw milk sold in different locations in Gariki, Okigwe, Imo State using standard laboratory techniques. A total of 60 raw milk samples were aseptically collected following standard methods from three different locations to determine total heterotrophic bacteria counts (TBC), total coliforms counts (TCC), and fecal coliforms counts (FCC). The total heterotrophic bacteria counts ranged between  $7.2\pm0.3\times10^3$  cfu/mlto  $6.9\pm0.1\times10^2$ cfu/mlwhile the total coliform counts ranged from  $7.2\pm0.2\times10^3$ cfu/mlto  $7.0\pm0.2\times10^2$ cfu/mland the total faecal coliform counts ranged between  $5.3\pm0.6\times10^4$ cfu/ mlto  $5.1\pm0.1\times10^4$ cfu/ml. The bacterial organisms identified and characterized include *Staphylococcus aureus*, *Escherichia coli, Salmonella* spp, *Pseudomonas aeruginosa, Shigella* spp *and Enterobacter* spp. The percentage distribution of the isolates indicated that *E. coli* and *Salmonella* spp had the highest rate of occurrence (100% respectively) while *Enterobacter* spp had the least occurrence rate (33.3%). There was no significant variation (at P=0.05) in the THBC, TCC and FCC in the samples collected from the different locations. The high level of counts and isolate numbers and types found in the sampled raw cow milk represent a poor keeping quality of milk and public health risk to the consumers. This suggests the need for improved hygienic practice at all levels of milk production in the Gariki community.

#### **INTRODUCTION**

Milk is used throughout the world as a human food in at least one form or more. Because of its high nutritive value, milk is considered as one of the most important diet items of many people. Nutritionally, milk has been defined as the most nearly perfect food. The demand of consumers for safe and high quality milk has placed a significant responsibility on dairy producers, retailers and manufacturers to produce and market safe milk and milk products (*Teshome et al.*, 2015).

Raw milk is most perishable, desirable and perfect food for human beings and animals. Due to its high water content, a pH close to neutral and also a diversity of nutrients, milk has become a perfect medium for the growth of several types of microorganisms which could lead to the deterioration of the milk. Presence and themultiplication of microorganisms cause changes in the quality of milk, thereby limiting its durability and bringing harm to the economy and also to public health (Barros *et al.*, 2011).

Raw milk has been a known vehicle for pathogens for more than 100years. Milk has been part of the human diet forthousands of years and it is a compulsory part ofdaily diet for expectant mothers as well as growing children. It contains lipids, proteins (casein, whey),carbohydrates (lactose), amino acids, vitamins andminerals (calcium), essential for growth (Javaid et al., 2009). It is a vital type of food for over 6 billion human beings all over the world and amajor contributor to food security.

Bacterial contamination of raw milk can originate from different sources: air, milking equipment, feed, soil, faeces and grass (Coorevits *et al.*, 2008). The number and types of micro-organisms in milk immediately after milking are affected by factors such as animal and equipment cleanliness, season, feed and animal health (Laba and udonsek, 2013).

According to U.S. Food and Drug Administration, the principal pathogens of concern associated with milk and processed milk products Salmonella spp., Listeria monocytogenes, are Staphylococcus aureus, pathogenic E. coli. Many of the common enteric pathogens such as Salmonella, Escherichia coli O157: H7 and Campylobacter are carried in the intestinal tract of ruminants, including domestic animals used in milk production, e.g. cows, sheep and goats. Effective cleaning procedures, including removing faecal material from udders prior to milking and good manufacturing practices during cheese making process can reduce the risk (Laba and Udonsek, 2013).

In Nigeria, raw milk is traditionally consumed at the small farms and in town where it is taken in addition with other food materials or process into soft cheese. The risk of contaminated and pathogen containing products could therefore be even greater than when the milk is processed at household level. The importance of various etiological agents in milk borne disease has changed dramatically over time. The presence of these pathogenic bacteria in milk emerged as major public health concerns, especially for those individuals who still drink raw milk. *E. coli* 0157:H7 has become serious threat to the dairy industries ranging from mild diarrhoea to potentially fatal hemolytic uremic syndrome (HUS), hemorrhagic colitis and thrombotic thrombocytopenic purpura (Saeed *et al.*, 2009). Therefore, this study is designed to evaluate the microbiological quality of raw milk sold in Gariki, Okigwe, Imo State, Nigeria.

Milk is sterile when it is in the udder of a healthy animal but becomes contaminated with bacteria mainly during and/or after milking (Makerere University, 2011). Milk from subclinical mastitic cows usually contains aetiological agents but milk from non-mastitic cows is often contaminated from extraneous dirt or poor quality water.

Microbial contamination in milk comes from milk itself as it can be naturally contaminated or comes from infected or sick animal, human, environment, water and equipment used for milking and storage of milk. These sources of contamination include disease-causing organisms (pathogens) shedding in milk, infected udder and/or teats, animal skin, faecal soiling of the udder, contaminated milking and storage equipment and water used for cleanliness.

Other bacterial sources are from air, milkers, handlers, drugs or chemicals used during treatment of animal and from water used for adulteration by unscrupulous and unfaithful workers/sellers which may be contaminated and may cause additional health problems (Swai and Schoonman, 2011).

Exposure of milk to these sources or conditions may lead to increased microbial contamination and affect its quality. Although, sometimes recontamination may occur after processing and is mainly due to unhygienic conditions, poor or improper handling of milk during consumption.

In general quality of milk may be lowered when it is contaminated by a number of factors such as adulteration, contamination during and after milking, presence of udder infections, mastitis (inflammation of mammary gland) disease and drugs residues used for treatment of disease which is considered to be public health concern and one of the most important causes of economic losses in the dairy industry worlwide including Morogoro and Tanzania at large (Mdegela *et al.*, 2009).

#### MATERIALS AND METHODS STUDY AREA

This study was conducted in Gariki area of Okigwe Local Government Area, Imo State. Gariki area is a popular region in Okigwe district predominantly inhabited by Hausa community. The major occupation of inhabitants of this area is cattle rearing. Therefore, trading and consumption of raw milk from these animals is a common practice in this region. The Latitude and Longitude of Okigwe Local Government Area, Imo State is 5.816667 and 7.35 respectively.

Laboratory analysis was performed to investigate the microbiological quality of raw milk sold locally in Gariki area of Okigwe, Imo State. A total of sixty samples of the raw milk were collected from three different spots in this area using sterile screwed bottles in the morning and transported in ice box filled with ice packs to the laboratory unit of Microbiology Department, Abia State University, Uturu for microbiological examination.

The microbial loads of various groups of bacterial species were determined using the culture techniques involving different culture media. Sixty different raw milk samples collected from three different spots were analyzed for the bacterial diversity as described earlier in the sample collection. Bioloads were determined after decimal serial dilutions. 9mls of distilled water were pipetted into ten test-tubes prepared in duplicate and labeled 10<sup>1</sup> to 10<sup>10</sup> for serial dilution. 1ml was taken from the stock sample and put into 10<sup>-1</sup> tube, this was mixed properly and from this 10<sup>-1</sup>, 1ml was transferred into 10<sup>-2</sup> tube. This was repeated, till the 10-9 tube using fresh 5ml pipette at each interval. 1ml was discarded from the last tube to make all equal (9ml each). A 0.2ml aliquots from the 10-9 tubes were aseptically inoculated onto different culture media (agar) using the spread plate techniques. Bacterial cultures were incubated at 37°C for 24hours with daily observation.

Various culture media were used. These were Nutrient Agar for Total Heterotrophic Bacterial Count (THBC), MacConkey Agar for Total Coliform Counts (TCC), EMB Agar for Total Faecal Coliform Counts (TFCC). Counting was done using colony counter. Pure bacterial isolates were identified based on their characteristics such as morphology, microscopy, staining ability and their biochemical reactions. The bacteria were stained using Gram's staining, spore staining and capsule staining methods.

The results obtained in this study were subjected to standard statistical analysis by the use of ANOVA. This was used to determine the significance of the results.

#### RESULTS

The results of the microbiological examination of the raw milk samples are shown in the tables below.

Table 3.1 reveals the results of the microbial loads of the raw milk samples. Total heterotrophic bacterial counts of the samples ranged between  $7.2\pm0.3\times10^3$  to  $7.1\pm0.3\times10^1$  while Total coliform counts ranged between  $7.2\pm0.2\times10^3$  to  $7.1\pm0.1\times10^2$ . Total faecal coliform counts ranged between  $5.3\pm0.6\times10^4$  to  $5.2\pm0.3\times10^2$ . At P<0.05, there

is no significant difference.

 Table 3.1: Total microbial counts of the raw milk samples

 PARAMETERS (cfu/ml)

		· · · ·	/
Samples	THBC	TCC	TFC
A(n=20)	$7.1 \pm 0.6 \times 10^{1}$	$7.1\pm0.1\times10^{2}$	$5.2{\pm}0.3{\times}10^{2}$
B(n=20)	$6.9\pm0.1\times10^{2}$	$7.0\pm0.2\times10^{2}$	$5.1{\pm}0.1{\times}10^4$
C(n=20)	7.2±0.3×103	$7.2\pm0.2\times10^{3}$	$5.3 \pm 0.6 \times 10^4$

Values are means expressed as mean  $\pm$  standard deviation.

Key:

*THBC= Total heterotrophic bacterial counts* 

TCC= Total coliform counts

TFC= Total faecal coliform counts

At P=0.05, there is no significant differences.

Table 3.2 below shows the results of the characterization and identification of the various bacterial isolates from the raw milk samples. *Escherichia coli, Pseudomonas aeruginosa, Salmonella* spp, *Shigella* spp, *Staphylococcus aureus and Enterobacter* spp *are the bacterial isolates from the samples.* 

Table 3.2: Identification of bacteria isolated from the various raw milk samples

MICROSCOPY					BI	OCI	HEN	<b>IIC</b> A	AL R	EAC	CTIC	ONS	5		CARBOHYDRATE UTILIZATION						
COLONY FEATURES	Cell Arrangement	Spore	Motility	Capsule	Catalase	Oxidase	Coagulase	Indole	Nitrate	MethylRed	V.P	Urease	H2S	citrate	Glucose	Sucrose	Lactose	Maltose	manitol	xylose	ORGANISM
Circular smooth colonies with light-yellow pigments on Mannitol Salt Agar (MSA).	Gram positive Group of oval cells	-	-	-	+	-	+	+	+	+	+	+	+	-	+	+	+	+	+	+	Staphylococcus aureus
Small pink shiny smooth colonies on MacConkey Agar (MA).	Gram negative short rods in singles	-	+	-	+	-	-	+	-	+	-	-	-	-	+	±	+	+	+	+	Escherichia coli
Non-lactose fermenting, ple coloured colonies with black centres	Gram negative short single rods	-	+	+	+	-	-	-	-	-	-	-	+	-	+	-	-	+	+	+	Salmonella spp.
Flat large spreading colonies with dark-blue colouration on nutrient agar (NA).	Gram negative single short rods and some short chains	-	+	+	-	+	-	-	-	-	-	-	-	-	+	-	-	-	+	-	Pseudomonas aeruginosa
Pale coloured colonies, non- lactose fermenting on MA.	Gram negative short rods in singles	-	+	-	-	-	-	+		-	-	-	-	-	+	+	+	-	-	+	Shigella species
Large mucoid pink colonies on MA	Gram negative short rods in singles	-	+	+	-	-	-	-	+	-	+		-	-	+	+	-	-	+	-	<i>Enterobacter</i> spp

*KEY*: + = *Positive*, - = *Negative*, *V*.*P* = *Voges*-*Proskauer*, *NA* = *Nutrient Agar*, *MA* = *MacConkey Agar* 

**Table 3.3** indicates the occurrence of the organisms within the raw milk samples. *E. coli* and *Salmonella* spp occurred in all the samples examined while *Enterobacter* spp had the least rate of occurrence.

 Table 3.3: Occurrence of the organisms within the raw milk samples

	Samples		
Organisms	Α	В	С
E. coli	+	+	+
P. aeruginosa	+	-	+
Salmonella spp	+	+	+
Shigella spp	-	+	-
S. aureus	+	-	+
Enterobacter spp	-	+	
Kev +=nositive -=	=Negative		

**Figure 3.1** below reveals the percentage distribution of the organisms within the raw milk samples. *E. coli* and *Salmonella* spp had the highest percentage distribution (100%) while *Enterobacter* spp had the least percentage distribution rate (33.3%).



**FIGURE 3.1:** Percentage distribution of the organisms within the raw milk samples

#### DISCUSSION

In this study, raw cow milk samples were analyzed for the presence and contamination levels of total heterotrophic bacterial counts, total coliform counts and total faecal coliform counts.

With this study, samples of raw cow milk which were offered for consumption in Gariki were analyzed for the presence of various micro organisms and their counts. The results of the microbiological analysis of the raw milk samples as shown in Table 3.1 is considered as having unacceptable hygienic quality when the Total heterotrophic bacterial counts exceeds  $1.0 \times 10^5$  cfu mL-1 according to EC Regulation (No. 853, 2004) of the European Parliament and of the Council (EC). In this study, the average THBC count was  $6.9\pm0.1\times10^2$  cfu/ml which is higher than the limits recommended by the agency. The findings in the present study were consistent with the results of Dan *et al.*, (2008) and Millogo *et al.*, (2010) whereas the total coliform counts and total feacal were higher than those reported by Al-Tahiri (2005) and Franciosi *et al.*, (2009). THBC is one of the main indicators of hygienic quality of cow's raw milk that is also used to set the purchase price of milk (Laba and Udonsek, 2013).

Table 3.2 shows the results of the characterization and identification of the various bacterial isolates from the raw milk samples. *Escherichia coli*, *Pseudomonas aeruginosa*, *Salmonella* spp, *Shigella* spp, *Staphylococcus aureus* and *Enterobacter* spp are the bacterial isolates from the samples.

The incidence of coliforms in raw milk has received considerable attention, partly due to their association with contamination of faecal origin and the consequent risk of more pathogenic faecal organisms being present, partly because of the spoilage their growth in milk at ambient temperatures can produce, and not least due to the availability of sensitive and rapid tests for detecting and enumerating coliforms. Coliform counts regularly in excess of 100 cfu/ml are considered by some authorities as evidence of unsatisfactory production hygiene. Sporadic high coliform counts may also be a consequence of unrecognised coliform mastitis, mostly caused by E. coli. The coliform micro-organisms are found also on the surface of the underwashed or moisture milking equipment (Karmen and Slavica, 2008).

The existence of coliform bacteria may not necessarily indicate a direct fecal contamination of milk but it is a precise indicator of poor sanitary practices during milking and further handling processes. The presence of fecal coliforms, i.e., *E. coli*, implies a risk that other enteric pathogens may be present in the sample (Fulya *et al.*, 2011).

Possible reasons for the high counts could be infected udders of the cows, unhygienic milking procedures or equipment and/or inferior microbiological quality of water used for cleaning utensil and animals as well as the milk storage conditions. Therefore, poor milk quality has often been considered as one of the major reasons for losses and it results in reduced income for the small holder dairies in Gariki area.

From the study, the potential pathogenic bacteria isolated includes *Staphylococcus aureus*, *Salmonella* spp., *Escherichiacoli*, *Pseudomonas aeruginosa*, *Shigella* spp. and *Enterobacter* spp. The incidence of *Salmonella* spp in the raw milk sample was high which pose health risk for the consumers if taken without pasteurization. De- Buyser (2011) reported that *Salmonella* is one of the most etiological agent responsible for several outbreaks associated with the consumption of raw milk and milk products. All *salmonellae* are of public health concern having the ability to produce infection ranging from a mild self-limiting form of gastroenteritis to septicemia and life threatening typhoid fever (Oliver *et al.*, 2015).

Thus, their presence in the raw milk sample pose a health risk to consumer that consumed it without any heat treatment. This problem is particularly evident indeveloped countries like England and Wales, where the most frequently reported out-breaks were salmonellosis associated with the consumption of rawmilk and products (Laba and Udonsek, 2013).

Salmonella spp and Escherichia coli was discovered in all the collected samples (Figure 3.1). An overview of annual reports of food borne diseases from several country indicated that S. aureus was far the most frequent pathogen associated with these food borne outbreak followed by Salmonella. S. aureus is considered the third most important cause of disease in the world amongst the reported food-borne illnesse. S. aureus poisoning is a mild, generally self-limiting disease, with symptoms that include vomiting with or without diarrhea (Dinges et al., 2010), hospitalization is required in approximately 10% of the cases. As a consequence food products mayoriginally become contaminated during the milking processes or after due to the fact that is can be foundon the body surfaces of animals and man. Tamarapu et al., (2011) reported that S. aureus has been isolated from several foods such as Chicken, meat, milk and dairy products, fermented food items, etc.

The bacteria of the genus *Enterococcus* spp., also known as *enterococci* are considered to be

important in foods as indicators of spoilage or potential pathogenic organisms. In dairy products, both *E. faecalis* and *E. faecium* species are relatively heat resistant as well. Most *enterococci* are also relatively resistant to freezing. Higher levels of *Enterococci* in milk are considered to be the result of contamination during the collection or processing of milk. The *Enterobacteriaceae* family has earned a reputation as being among the most pathogenic and most often encountered organisms in food (Fulya, 2011).

## CONCLUSION

The results of this study revealed that microbiological quality of the raw milk samples examined was below the acceptable limit with respect to the total bacteria count. The presence of pathogenic and indicator bacteria, such as *E. coli*, coliforms and *S. aureus* indicate that the growth of these organisms may lead to a hazard against public health. Therefore practice and regulations, such as on-site pasteurization and implementation of HACCP following established standards, should be introduced to facilitate the production of cow milk of high quality and safety.

To avoid the increase of the number of microorganisms the European Regulative 853 (2004) recommends that immediately after milking, milk must be held in a clean place designed and equipped to avoid contamination. It must be cooled immediately to not more than 8 °C in the case of daily collection, or not more than 6 °C if collection is not daily. During transport the cold chain must be maintained and on arrival at the establishment of destination, the temperature of the milk must not be more that 10 °C (Regulation EC 853, 2004).

## REFERENCES

- Al-Tahiri, R., (2005). A comparison on microbial conditions between traditional daily products sold in Karak and same products produced by modem dairies. *Pak. Journal of Nutrition.*, 4, 345-348.
- Barros, L. S., Soglia, S. L. O., Ferreira, M. J., Rodrigues, J. & Branco, M. P.C (2011). Aerobic and anaerobic bacteria and Candida species in crude milk. *Journal of Microbiol. Antimicrob.*, 3, 206-212.

Coorevits, A., De-Jonghe, V., Vandroemme, J., Reekmans, R, Heyrman, J., Messens, W., De Vos, P. & Heyndrickx, M.(2008) Comparative analysis of the diversity of aerobic-spore-forming bacteria in raw milk from organic and conventional dairy farms. *System. Journal of Appllied. Microbiology.*, 6, 25.

Dan, S. D., Mihaiu, M., Rotaru, O. & Dalea, I. (2008). Evaluation of microbiological load and configuration of raw milk from collecting centres in CLUJ country. *Bul. Vet. Med.*, 65, 346-352.

De Buyser, M. L., Dufour, B., Marie, M. & Lafarage, V. (2011) Implications of milk and milk products in food borne diseases in France and in different industrialized countries. *International Journal of Food Microbiology.*, 67,1-17.

- Dinges, M., Orwin, P.M. & Schlievert, P. M.(2010). Exotoxins of *Staphylococcus aureus*. Clinical. *Microbiology Rev.*, 13, 16–34.
- Franciosi, E., Pelle, A., Cavazza, A. and Posnanski, E. (2009). Microbiological monitoring of raw milk from selected farm in the Trentingrana region. *Ital. J. Amin. Sci.*, 8, 408 410.
- Fulya, T. (2011). Microbiological and Chemical Properties of Raw Milk Consumed in Burdur. *Journal of Animal Vetetinary. Adv.*, 10 (5),635-641.

Javaid, S. B. Gadahi, J. A., Khaskeli, M., Bhutto, M. B., Kumbher, S. & Panhwar, A. H (2009). Physical and chemical quality of market milk sold at Tandojam, Pakistan. *Pak. Veternary Journal*, 29(1), 27-31.
 Makerere University, School of Veterinary Medicine, (2011). *Dairy Products Quality and Safety Module*, Pp

38.

- Mdegela, R. H., Ryoba, R., Karimuribo, E. D., Pire, E. J., Løken, T., Reksen, O., Mtengeti, E. & Urio, N. A. (2009). Prevalence of clinical and subclinical mastitis and quality of milk in smallholder dairy farms in Tanzania. *J. South Afr. Veter. Assoc.*, 80(3),163 168.
- Millogo, V., K. S. Sjaunja, G. A. Ouedraogo & Agenas, S. (2010). Raw milk hygiene at arms, processing units and local markets in Burkina Faso. *Food Control*, 21,070-1074.
- Regulation (EC) No.853/2004 of the European Parliament and of the Council of 29. April 2004 laying down specific hygiene roles for food and animal origin. *Officional Journal European Communities*, 1(226), 22–82.
- Saeed, A. E. A, Zubeir, E. M. & Owni, O. A. O (2009). Antimicrobial resistance of bacteria associated with raw milk contaminated by chemical preservatives. *World J. Dairy Food Sci.*, 4(1),65-69.
- Teshome, G., Fekadu, B. and Mitiku, E. (2015). Physical and chemical quality of raw cow's milk produced and marketed in Shasemene Town, Southern Ethiopia. *Journal of Food Agricultural Science*, 5(2): 7-13.





AGRICULTURAL AND BIOLOGICAL SCIENCES

## PLASMA ANTIOXIDANT MICRONUTRIENTS LEVEL OF APPARENTLY HEALTHY ADULTS AFTER A DIETARY INTERVENTION BASED ON AGE AND GENDER IN NASARAWA STATE UNIVERSITY, KEFFI, NIGERIA

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#### ABSTRACT

Immunologic functions particularly cell-mediated immunity declines with age, contributing to the increased incidence of infectious diseases in the elderly. The study looked at vitamin C, vitamin E, and  $\beta$ -carotene levels in plasma of 150 healthy adults of 96 men and 54 women aged between 30 and 74 years. The subjects were randomly grouped into three at baseline for further dietary studies. either 1 capsule per day of antioxidant nutraceutical (Forever living product) (containing vitamin E 10 mg, vitamin C 60mg and  $\beta$ - carotene 2000 mcg of vitamin A, or cheap affordable indigenous antioxidant functional foods of equivalent vitamin composition of oranges, carrots, and soybean or bottled water, and the first dose was dispensed and followed up for six months. The result showed that the vit C,E and  $\beta$ -carotene concentration of antioxidant treated groups were positively influenced than the placebo group (Grp 1 (AT-P)6m. Grp 3 (AT-F)6m was affected more positively than the antioxidant Grp 2 (AT-N)6m. Vitamin C, E, and  $\beta$ -carotene concentrations of the elderly are beyond reference/normal range of blood plasma. Plasma Vitamin C and  $\beta$ -carotene concentration of the female was higher than the male. There vitamin E concentration in blood plasma of male is higher compare to female.

Keywords: Blood, antioxidants, aging, gender, micronutrients

## **INTRODUCTION**

Immunologic functions particularly cell-mediated immunity declines with age, contributing to the increased incidence of infectious diseases in the elderly. Cellular immune functions and health generally are compromised at older age due to severe nutritional deficiency. Nutrition may play a pivotal role in maintaining immune competence in older adults. The maintenance of immune cells and preserving their adequate function are strongly influenced by antioxidant/oxidant balance. Thus, the level of anti-oxidants in these cells plays a pivotal role in protecting them from oxidative stress (Knight, 2009).

Free radicals are incriminated in the pathogenesis of tissue injury in many diseases in ageing, as well as obstruction of normal physiological functions. They produce cellular injury by lipid peroxidation, enzyme activation, DNA damage and degradation of structural protein. The body has evolved multiple defence mechanism through antioxidants against free radicals, by preventing the formation of radicals (chain termination), scavenging them or promoting their decomposition .( Shi et This enzymatic and non-enzymatic al., 2012). antioxidant includes Vitamin C, E, A, carotenoids, superoxide dismutase (SOD), catalase, glutathione peroxidase (GPx). New concept of the application/ approach of antioxidant supplement has appeared as nutraceuticals, functional foods, nutritional therapy, and phytonutrients (Bland, 2006; Berger and Shenkin, 2006). Whole foods represent the simplest example of functional foods (carrots, orange, soybeans and avocado pear) because of their high contents of physiologically active components (β- carotene, Vitamin C, Vitamin E, and Lycopene respectively). They satisfactorily demonstrate a beneficial effect on one or more target functions in the body, beyond adequate nutritional effect, relevant to well-being and reduction to health risk Lopez-Varella et al., 2002). More specifically, antioxidants maintain the integrity and function of membrane lipids, cellular proteins, and nucleic acids and the control of signal transduction of gene expression in immune cells. For this reason the immune cells are particularly sensitive to changes in their antioxidant status.

Antioxidant vitamins (Ascorbic acid and tocopherol) and carotenoids have been suggested to play important role in cellular immunity and cardiovascular diseases (Mates *et al.*, 1999;Diplock, 2004; Ballali and Lancia, 2013). Vitamin C is found in high concentration in white blood cells and is rapidly utilized during infection; reduced plasma concentrations are often associated with

reduced immune function (Siegel and Massague, 2003) Vitamin C provide important protection for plasma lipid and lipid membranes and can neutralize phagocyte-derived oxidants released extracellular, thereby preventing oxidant mediated tissue damage (Anderson et al., 2006). Vitamin E is the most effective chain-breaking, lipid soluble antioxidant present in cell membranes, thus play a role in limiting lipid peroxidation as well as in immune cell function (Gardener *et al.*, 1996).  $\beta$  -carotene in a study was shown to have significant antioxidant properties and effectively quenches singlet oxygen free radicals than vitamin A Saloneu, 2003). B-carotene and some other antioxidant carotenoids can enhance many aspects of immune functions (Gardener et al., 1996). Micronutrients deficiency is common in ageing, pregnancy and ill health (Stephen et al., 2000). These deficiencies may contribute to an increased risk of parasitic infection, and oxidative stress which affect the production of blood cells and haemoglobin and the entire immune level (Mahomed, 2000). Biochemical investigation of average Nigerians of different ages and of both sex will be carried out, with regards to serum level of specific micronutrients. on cellular immunity. This study is focused on the evaluation of blood biochemical analysis of humans on micronutrients (Vitamin C, E, and  $\beta$ - carotene) of adults on different ages.

#### MATERIALS AND METHODS

The study was conducted in Keffi town, Nasarawa State, Nigeria. Nasarawa state is located in the north central geopolitical zone of Nigeria. It lies between latitude 80°35N and longitude 08°36'E. A single- centred open dose study was employed. The volunteers were randomly assigned to three groups with 3 sub-groups based on three intervals of baseline, six months and twelve months. Group 1; No antioxidant treatment was given for the twelve months but a 75 cl bottled water- placebo group ( Grp 1 (BT)0m: placebo basaline group, Grp 1 (AT-P)6m: placebo six months group, GRP 1 (AT-P)12m: placebo twelve months group). Group 2; the group that later received antioxidant nutraceuticals Forever living product 1 capsule per day of (vitamin E (10mg), vitamin C (60mg) and  $\beta$ - carotene(2,000mcg of vit A)-nutraceutical treatment group (Grp 2 (AT-N)0m: baseline group that were later given antioxidant nutraceuticals, Grp 2 (AT.N)6m: nutraceutical treatment group that received antioxidant for six months, Grp 2 (AT-N)<sub>12m</sub>: nutraceutical treatment group that reived antioxidant for twelve months). Group 3; the group that later received antioxidant functional foods of equivalent vitamin composition

oranges (100g), carrots (100g), 75cl soybean drink and a heaped tablespoon of powdered soybean (35g) daily-functional group treatment group (Grp 3 (AT-F)0M: baseline group that was later given antioxidant, Grp 3 (AT-F)<sub>6M</sub>: functional food treatment group that received antioxidant for six months, Grp 3 (AT-F)<sub>12M</sub>: functional food treatment group that received antioxidant for twelve months).

The study subjects were a total of 150 healthy adults of 96 men and 54 women aged between 30 and 74 years, with a body mass index within the range of <18 to 39.90 kgm-2. All women are staff (academic staff, senior staff, and non- academic) of Nasarawa state University, Keffi.

The subjects had no history of gastrointestinal surgery, or other significant pathology, were not on a caloric- reduced or vegetable diet nor were taking any antioxidant/vitamin supplement, female were not pregnant or lactating. No concomitant medication was allowed throughout the study except the contraceptive pill.

The protocol was reviewed and approved. The scope, nature, aim and objectives of this study were thoroughly explained to voluntary participants for their consent, and were all made to sign an informed consent letter and a questionnaire. Three hundred (300) volunteers' veinous blood samples were taken by local physicians from the University staff clinic and clinical records were taken. Participants with desirable health status were chosen randomly. Blood biochemical analysis/assays on micronutrients and β-carotene assay were carried out at Nigerian Institute of Pharmaceutical Research and Development, Idu Industrial District, Abuja, Nigeria. Determination of Micronutrients (B-carotene, Vitamin E and Vitamin C in blood plasma) were measured by the method of Simultaneous determination of vitamins C,E and  $\beta$ -carotene in human plasma by high performance chromatography with photodiodes-array liquid detection (Zhao et al., 2004). Based on distribution equilibrium which is the differences in solubility and adsorption of a component in two immiscible phases, based on separation science in which a liquid mobile phase is percolated through a column.

The experimental results were analysed statistically using one-way analysis of variance (ANOVA) for comparing the mean using Smith's Statistical package (SSP).

#### **RESULTS AND DISCUSSION**

Table 1 Showed that the vitamin C concentration of antioxidant treated groups were positively influenced than the placebo group (Grp 1 (AT-P)<sub>6m</sub>. Grp 3 (AT-F)<sub>6m</sub> were affected more positively than the antioxidant Grp 2 (AT-N)6m. The results showed that vit c

concentration of most of the elderly were lower than that of the younger adults. Also, vit c concentration of the female was higher than that of male. The vit c concentration of most on the age range 60-79 are beyond reference/normal range of blood plasma vit c in both male and female but increased positively to the reference range after the antioxidant intervention. The serum vitamin C of Grp 1 (AT-P) at six months showed a significant different at the age groups except for the both sexes of age group 30-39, male of age group 40-49 and female of age group 60-69 while at twelve months there was significant difference in all it was noted that at extreme ages there was negative increament. Grp 2 (AT-N) at six showed a significant difference in all ages of males and females. Grp 3 (AT-F) at six months also showed a significant difference in all ages of males and females.

The vit E concentration of the antioxidant treated groups was positively influenced than the placebo group (Grp 1 (AT-P) at six months. Grp 3 (AT-F) at six months was affected more positively than the antioxidant Grp 2 (AT-N) at six months. The result showed that the males have higher levels of vit E compare to females of the same age. It was noted that the vit E concentration in blood plasma decreases with increase in age. The serum vitamin E of Grp 1 (AT-P)<sub>6m</sub> showed a significant different in negative decrease at the age groups when compared to Grp 1 (BT) except for the male age group of 30-39, 40-49, 50-59 and 60-69. while Grp 2 (AT-N) at six months showed a significant difference in positive increase. Grp 3 (AT-F) at six months showed a significant difference at all the age groups of males and females. The  $\beta$ -carotene concentration of antioxidant treated groups at six months was positively influenced than the placebo group (Grp 1 (AT-P) at six months. Grp 3 (AT-F) at six months was affected more positively than the antioxidant Grp 2 (AT-N) at six months. The result showed that the females have higher and normal levels of  $\beta$ -carotene compare to males of the same age. The result showed that most elderly (50-79) has low  $\beta$ -carotene concentration lower than the normal range in blood plasma and that it decreases with increase in age. The serum  $\beta$ -carotene of Grp 1 (AT-P)<sub>6m</sub> showed a significant difference in negative decrease at all the age groups except for both sexes of age group 40-49, male of age group 50-59 and female of age group 60-69. Grp 3 (AT-F) at six months showed a significant different in positive increase at all age groups of males and females. Grp 2 (AT-N) at six months showed a significant different in positive increase at all age groups of male and females.

This study showed that the antioxidant dietary intervention significantly improved these micronutrients and  $\beta$ -carotene levels in blood, *FULafia Journal of Science & Technology Vol. 2 No.1 March, 2016* 

with antioxidant functional foods affecting the micronutrients and β-carotene better than antioxidant nutraceuticals. Micronutrients deficiency is common in ageing, pregnancy and ill health (Stephenson et al., 2000; Nancy et al., 2015). These deficiencies may contribute to an increased risk of parasitic infection, and oxidative stress which affect the production of blood cells and haemoglobin and the entire immune level (Mohamed, 2000; Nweze et al., 2015). The study showed that there is synergism between  $\alpha$ -tocopherol, β-carotene and ascorbic acid. Ascorbic acid acts in an aqueous phase (Weber et al., 1996; Mubo et al., 2015), whereas  $\alpha$ -tocopherol and  $\beta$ -carotene act in the lipophilic compartments (Edge et al., 1997; Hussain et al., 2015). Chemically,  $\beta$ -carotene is less reactive toward radicals than are α-tocopherols and ascorbic acid (Edge et al., 1997; Saeed et al., 2015). Ascorbic acid and a-tocopherol inhibit oxidation synergistically (Packer et al., 1979; Niki et al., 1982; Bascetta et al., 1983; Umadevi et al., 2015). Though α- tocopherol is more effective than ascorbic acid in scavenging radicals in membrane and lipoproteins (Gonez et al., 1989; Parker et al., 2015). Ascorbic acid reduces the resulting α-tocopheroxyl radicals (Niki et al., 1984; Saeed et al., 2015).  $\alpha$ -tocopherol and  $\beta$ -carotene may be assumed to have a cooperative effect by residing and scavenging radicals at different positions in the compartment (Edge et al., 1997; Parker et al., 2015). In conclusion, the combination of  $\alpha$ -tocopherol,  $\beta$ -carotene and ascorbic acid can be said to be effective in inhibiting oxidative damage which showed in the cellular immunity of the volunteers in the antioxidant intervention groups studied.

Vitamin C concentration in plasma showed no significant difference in ages of male compared to female (Table 1), indicating that female has higher Vitamin C concentration. Also, the vitamin C concentration of the elderly was beyond the normal range, showing lower vitamin than that of the adults. Some studies indicate that Vitamin C increases circulating immunoglobulin (Ig) levels in humans (Stardam, 2004). Vitamin C provide important protection for plasma lipid and lipid membranes and can neutralize phagocyte-derived oxidants released extracellular, thereby preventing oxidant mediated tissue damage (Anderson, et al., 2004). This study showed that Vitamin C concentration showed no significant difference between the male and female levels.. This study conform to previous study in Helena that Vitamin C evaluation on blood of volunteers for cancer research that the female has higher Vitamin C level than male (Smirnoff, 2001; Sies et al., 2005). Vitamin C level of elderly has shown to be lower than that of the young adults.

It was observed that Vitamin E level significantly decreases with increase in age of both male and female. A study showed that there was a negative association between plasma Vitamin E levels and incidence of infections in healthy adults aged over 60years (Sokol, 2008). The latter effect is probably due to the increase in production of free radicals and related species in ageing (Meydani et al., 2010), and tends to increase from infancy to adolescent (Sokol, 2008). Results obtained on  $\beta$ -carotene concentration showed that the female  $\beta$ -carotene is significantly higher than in male. The result also showed that  $\beta$ -Carotene decreases with age. In respect to age, the study conforms to report on micronutrients of adults that  $\beta$ -carotene concentration of male and female decrease with age (Ventura et al., 2004).

## CONCLUSION

Aging which is a multifactorial process in which free radical oxidative damage plays a very important role and antioxidant defence mechanisms in humans, such as antioxidative enzymes, tocopherol, ascorbic acid and  $\beta$ -carotene are linked to each other balance with reactive oxygen species (Ventura *et al.*, 2004). The study showed that all parameters evaluated and assayed increase/decrease with increased age to the extreme value of the normal/reference range.

## RECOMMENDATION

Generally, the abnormal increase and decrease of these various biochemical parameters in the blood can be improved by increasing concentration of dietary foods containing antioxidant. This deficiency greatly affects the immune system and increases the rate of ageing of individuals of either sex.

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Groups	30	-39	40-4	49		50-59	60-6	59	70-	79
	М	F	М	F	М	F	М	F	М	F
Baseline										
Grp 1 (BT) <sub>0m</sub>	42.00±0.03	46.00±0.03	40.00±0.05	45.00±0.09	41.00±0.10	44.00±0.10	40.00±0.06	45.00±0.06	33.00±0.03	42.00±0.00
Grp 2 (BT) <sub>0m</sub>	40.00±0.02	47.00±0.04	39.00±0.07	45.00±0.10	40.00±0.09	45.00±0.08	40.00±0.05	44.00±0.05	29.00±0.00	43.00±0.03
Grp 3 (BT) <sub>0m</sub>	41.00±0.03	46.00±0.02	40.00±0.06	45.00±0.09	40.00±0.09	44.00±0.10	41.00±0.05	44.00±0.06	31.00±0.04	43.00±0.00
Antioxidant Treatn	nent (6 months)									
Grp 1 (AT-P)	42.00±0.03	46.00±0.03	40.00±0.06	46.00±0.07ª	42.00±0.03ª	45.00±0.05ª	41.00±0.02ª	45.00±0.02	31.00±0.01ª	$40.00 \pm 0.00^{a}$
Grp 2 (AT-N) 6m	46.00±0.02b	$57.00 \pm 0.04^{b}$	45.00±0.06b	$55.00{\pm}0.05^{b}$	45.00±0.05 <sup>b</sup>	$5.00\pm0.06^{b}$	46.00±0.02 <sup>b</sup>	54.00±0.04 <sup>b</sup>	$36.00{\pm}0.00^{b}$	$53.00{\pm}0.01^{b}$
Grp 3 (AT-F) <sub>6m</sub>	48.00±0.04 <sup>c*</sup>	58.00±0.03°	47.00±0.05°*	57.00±0.05°	46.00±0.06°	56.00±0.06°	48.00±0.03 <sup>c*</sup>	56.00±0.03°*	38.00±0.01°*	55.00±0.00°*

Reference value: 36.1-79.4 (µmol/L); Grp 1 (BT): Group 1 before treatment; Grp 2 (BT): Group two before treatment; Grp 3 (BT): Group 3 before treatment; Grp 1 (AT-P) <sub>6m</sub>: Group 1 after treatment- placebo; Grp 2 (AT-N) 6m: Group 2 after treatment- nutraceuticals; Grp 3 (AT-F) <sub>6m</sub>: Group 3 after treatment- functional food; p<0.05 was considered statistically significant; n: 150; <sup>a</sup>: was considered statistically significant; n: 150; <sup>b</sup>: was considered statistically significant when compared with Grp 2 (BT); <sup>c</sup>: was considered statistically significant when compared with Grp 3 (BT); <sup>b</sup>: was considered statistically significant when compared with Grp 2 (AT-F) <sub>6m</sub>.

#### Table 2: Effect of antioxidants on Serum Vitamin E (µmol/L)

Groups	30	)-39	40-4	49	50-5	9	60-6	59	70-79	
	М	F	М	F	М	F	М	F	М	F
Baseline										
Grp 1 (BT)0m	46.00±0.02	46.00±0.02	47.00±0.11	47.00±0.11	38.00±0.08	38.00±0.08	27.00±0.06	27.00±0.06	23.00±0.04	23.00±0.04
Grp 2 (BT)0m	46.00±0.04	32.00±0.03	37.00±0.10	37.00±0.09	27.00±0.07	30.00±0.10	24.00±0.05	25.00±0.50	21.00±0.00	24.00±0.02
Grp 3 (BT)0m	48.00±0.03	37.00±0.04	47.00±0.09	38.00±0.08	28.00±0.10	26.00±0.11	25.00±0.07	25.00±0.09	22.00±0.04	22.00±0.00
Antioxidant Treatm	ent (6 months)									
Grp 1 (AT-P) 6m	46.00±0.03	36.00±0.02a	47.00±0.05	36.00±0.08ª	38.00±0.04	32.00±0.07ª	26.00±0.03	23.00±0.04ª	22.00±0.02ª	21.00±0.00ª
Grp 2 (AT-N) 6m	54.00±0.04b	38.00±0.03b	45.00±0.08b	42.00±0.07 <sup>b</sup>	35.00±0.06 <sup>b</sup>	35.00±0.03b	32.00±0.03b	30.00±0.02b	29.00±0.00b	29.00±0.01b
Grp 3 (AT-F) <sub>6m</sub>	58.00±0.03°*	45.00±0.04°*	57.00±0.07°*	46.00±0.08°*	38.00±0.05°*	34.00±0.05°	35.00±0.04°*	33.00±0.04°*	32.00±0.02°*	30.00±0.00°

Reference value: >28 ( $\mu$ mol/L); Grp 1 (BT): Group 1 before treatment; Grp 2 (BT): Group two before treatment; Grp 3 (BT): Group 3 before treatment; Grp 1 (AT-P) (m): Group 1 after treatment- placebo; Grp 2 (AT-N) (m): Group 2 after treatment- nutraceuticals; Grp 3 (AT-F) (m): Group 3 after treatment- functional food; p < 0.05 was considered statistically significant; n: 150; \*: was considered statistically significant when compared with Grp 2 (BT); \*: was considered statistically significant when compared with Grp 2 (AT-F) (m): Group 2 (AT-F) (m): Group 3 after treatment- functional food; p < 0.05 was considered statistically significant; n: 150; \*: was considered statistically significant when compared with Grp 3 (BT); \*: was considered statistically significant when compared with Grp 2 (AT-F) (m): Group 3 (BT); \*: was considered statistically significant when compared with Grp 3 (BT); \*: was considered statistically significant when compared with Grp 3 (BT); \*: was considered statistically significant when compared with Grp 2 (AT-F) (m): Group 3 (BT); \*: was considered statistically significant when compared with Grp 3 (BT); \*: was considered statistically significant when compared with Grp 3 (BT); \*: was considered statistically significant when compared with Grp 3 (BT); \*: was considered statistically significant when compared with Grp 3 (BT); \*: was considered statistically significant when compared with Grp 4 (AT-F) (m): Group 3 (BT); \*: was considered statistically significant when compared with Grp 5 (BT); \*: was considered statistically significant when compared with Grp 5 (BT); \*: was considered statistically significant when compared with Grp 5 (BT); \*: was considered statistically significant when compared with Grp 5 (BT); \*: was considered statistically significant when compared with Grp 5 (BT); \*: was considered statistically significant when compared with Grp 5 (BT); \*: was considered statistically significant when compared with Grp 5 (BT); \*: was considered statistically significant when c

#### Table 3: Effect of antioxidants on Serum $\beta$ – Carotene (µmol/L)

Groups	30-	39	40-49		50-5	9	60-69		70-7	79
	Μ	F	Μ	F	Μ	F	М	F	Μ	F
Baseline Grp 1 (BT)0m Grp 2 (BT)0m Grp 3 (BT)0m	0.84±0.02 0.96±0.02 1.03±0.04	1.09±0.01 1.20±0.04 1.30±0.03	$\substack{0.81 \pm 0.09 \\ 0.91 \pm 0.11 \\ 0.94 \pm 0.10}$	0.90±0.07 1.15±0.08 1.17±0.09	0.76±0.10 0.87±0.09 0.84±0.09	$0.90\pm0.10$ $0.90\pm0.08$ $0.98\pm0.10$	$0.58 \pm 0.06$ $0.68 \pm 0.05$ $0.72 \pm 0.04$	0.80±0.06 0.80±0.07 0.96±0.07	$0.49\pm0.03$ $0.25\pm0.00$ $0.37\pm0.03$	0.70±0.04 0.70±0.02 0.65±0.04
$\begin{array}{l} \textbf{Antioxidant Treatment (6}\\ \text{Grp 1 (AT-P)}\\ \text{Grp 2 (AT-N)}_{6m}\\ \text{Grp 3 (AT-F)}_{6m} \end{array}$	<b>months)</b> 0.82±0.02a 1.96±0.02 <sup>b</sup> 2.53±0.04 <sup>c*</sup>	1.05±0.01a 2.70±0.04 <sup>b</sup> 3.30±0.03 <sup>c*</sup>	0.80±0.07 1.94±0.07 <sup>b</sup> 2.44±0.09 <sup>c*</sup>	0.90±0.07 2.65±0.07 <sup>b</sup> 3.16±0.05 <sup>c*</sup>	0.75±0.08 1.86±0.05 <sup>b</sup> 2.34±0.04c	0.80±0.05ª 2.40±0.03 <sup>b</sup> 2.98±0.04 <sup>c*</sup>	0.55±0.03 <sup>a</sup> 1.65±0.03 <sup>b</sup> 2.22±0.03 <sup>c*</sup>	$\begin{array}{c} 0.80{\pm}0.04\\ 2.30{\pm}0.02^{b}\\ 2.95{\pm}0.03^{c^{*}} \end{array}$	$\begin{array}{c} 0.45{\pm}0.02^a \\ 1.20{\pm}0.00^b \\ 1.87{\pm}0.02^{c^*} \end{array}$	0.60±0.00 <sup>a</sup> 2.20±0.01 <sup>b</sup> 2.93±0.00 <sup>c4</sup>

Reference value: 0.93-5.58 ( $\mu$ mol/L); Grp 1 (BT): Group 1 before treatment; Grp 2 (BT): Group two before treatment; Grp 3 (BT): Group 3 before treatment; Grp 1 (AT-P) (m): Group 1 after treatment- placebo; Grp 2 (AT-P) (m): Group 2 after treatment- nutraceuticals; Grp 3 (AT-F) 6m: Group 3 after treatment- functional food; p<0.05 was considered statistically significant; n: 150; \*: was considered statistically significant when compared with Grp 1 (BT); \*: was considered statistically significant when compared with Grp 2 (BT); \*: was considered statistically significant when compared with Grp 2 (BT); \*: was considered statistically significant when compared with Grp 2 (BT); \*: was considered statistically significant when compared with Grp 2 (AT-F) (m): \*: was considered statistically significant when compared with Grp 2 (AT-F) (m): \*: was considered statistically significant when compared with Grp 2 (BT); \*: was considered statistically significant when compared with Grp 2 (BT); \*: was considered statistically significant when compared with Grp 2 (BT); \*: was considered statistically significant when compared with Grp 2 (BT); \*: was considered statistically significant when compared with Grp 2 (BT); \*: was considered statistically significant when compared with Grp 2 (BT); \*: was considered statistically significant when compared with Grp 2 (BT); \*: was considered statistically significant when compared with Grp 2 (BT); \*: was considered statistically significant when compared with Grp 2 (BT); \*: was considered statistically significant when compared with Grp 2 (BT); \*: was considered statistically significant when compared with Grp 2 (BT); \*: was considered statistically significant when compared with Grp 2 (BT); \*: was considered statistically significant when compared with Grp 2 (BT); \*: was considered statistically significant when compared with Grp 2 (BT); \*: was considered statistically significant when compared with Grp 2 (BT); \*: was considered statistically significant \*: was considered statistical

#### REFERENCES

- Anderson, J. Salzer, C. L. and Kumar, J. P. Regulation of the retinal determination gene dachshund in the embryonic head and developing eye of drosophilla. *Dev. Biol.*, 2006; 297 (2): 536-549
- Ballali, S. and Lanciai, F. Functional food and diabetes: a natural way in diabetes prevention? *Int. J. of Food Sci. and Nutr.* 2013; 63(1): 51-61.
- Berger, M.M. and Shenkin, A. Vitamins and trace elements: Practical aspects of supplementation. *Nutrition*. 2006; 22:952-55
- Bland, J.S. Phytonutrition, pyhtotherapy and phytopharmacology. Altern Ther Health Med. 2006; 2:73-76.
- Diplock ,A. T. Antioxidants and Free radical Scavangers. In: Free radical damage and its control, Rice Evans, CA and RH Burdon (Eds). Elsevier Science, UK.2004; 113-129.
- Gardner, E.M., Bernistein, E.D., Dorfman, M., Abreutyn, E. and Maurasko, D. M. The age-associated decline in immune function of healthy individuals is not related to changes in plasma concentrations of β-carotene, retinol, α-tocopherol or zinc, Mech Ageing Dev 1997; 94: 55-69.
- Knight, J. Free radicals, their history and current status in aging and disease. Ann Clin Lab Sci. 2009; 28:331-46
- Lopez-Varela, S., Gonzαlez-Gross, M. and Marcos, A. Functional foods and the immune system: A review. *Eur J Clin Nutr.* 2002; 56:529.
- Mahomed, K. Iron supplementation in pregnancy Rev 2000; 2: 11-17
- Mates, J.M., Perez-Gomez, and De Castro, I. N. Antioxidant enzymes and human diseases. *Clin Biochem* 1999; 32: 595-603.
- Meydani, S.N., Barklung, M. P. and Siu, S. Vitamin E supplementation enhancers cell-mediated immunity in healthy elderly subjects. *Am J. Clin Nutr* 2010; 52: 557-63
- Meydani, S.N., Meydani, M. and Blumberg, J.B. Vitamin E supplementation and in vivo immune response in healthy subjects: 8 randomisrd controlled trial. JAMA 1997;277: 1380—6.

- Saloneu, R.M. Six year effect of combined vitamin C, E, and β- carotene supplementation on artheriosclerotic progression. Circulation, 2003;1, 947-953.
- Shi, H.L., Noguchi, N. and Niki, N. Comparative study on dynamics of antioxidative action of α-tocopheryl hydroquinone, ubiquinol and α-tocopherol, against lipid peroxidation. Free Radic Biol Med 2012; 27: 334-46.
- Siegel PM, J. and Massague Cytostate and apoptotic activities of TGF- beta in homeostatis and cancer Pubmed Nat.Rev Cancer, 2003; 3: 807-21.
- Sies, H. and Stahl, W. Vitamins E, C, and β- carotene, and other carotenoids as antioxidants. *Am. J clin Nutr;* 2005; 62: 1315s-21s.
- Smirnoff, N. L-ascorbic acid biosynthesis. Vitam Horm; ., 2001; 61: 241-66.
- Sokol, R.J. Vitamin E deficiency and neurologic diseases, Annu Rev Nutr; 2008; 8: 351-73.
- Stardam, E.R. Role of oxidant species in aging.. Curr. Med. Chem., . 2004; 11: 1105-1112
- Stephen ,L.S., Lathan, M.C. and Ottesen, E.A. Malnutrition and parasitic infections. *Parasitol.* 2000; 121: 532-538.
- Ventura, M.T., Serlenga, E., Torterella, C. and Antonaci, S. In vitro vitamin E and B-carotene, selenium supplementation improves neutrophil-mediated functions and monocyte chemoattractant proteins-1 production in the elderly, Cytobios 2004; 77: 225-32.
- Zhao, B., Tham, S.Y., Lu, J., Lee, L.K. and Moochhala, S.M. Simultaneous determination of vitamins C,E and b-carotene in human plasma by high performance liquid chromatography with photodiodes-array detection; *J. pharm pharm sci.* 2004; 30: 72-87





AGRICULTURAL AND BIOLOGICAL SCIENCES

## SOIL PHYSICO-CHEMICAL PROPERTIES AND MICROFLORA AS INFLUENCED BY

## **PARAQUAT APPLICATIONS**

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#### ABSTRACT

A field experiment was conducted to investigate the effects of paraquat (1, 1'-di methyl-4,4'-biyridinium dichloride) at the recommended and twice the recommended field application rates on soil physicochemical properties and microorganisms. The effects of the herbicide on soil pH, organic carbon, nitrogen, phosphorus content and cation exchange capacity were analyzed along with microbial populations and the growth and distribution of representative soil microorganisms were obtained using standard procedures. There was no significant effect of paraquat on soil physicochemical properties at P>0.05. Paraquat applications at both concentrations caused reduction in the bacterial and fungal populations with twice the recommended rate having more adverse effect when compared with the control while the fungal populations were more adversely affected than the bacteria populations by herbicide treatment. Reduced number of predominant bacteria and fungi genera as well as the elimination of some secondary genera as observed in paraquat treated soils could be detrimental to the sustainability of soil fertility. These results are discussed in line with the soil management practices for sustainable crop production.

Key words: Paraquat, Soil, Bacteria, Fungi, Physicochemical properties

## INTRODUCTION

Many peasant farmers in many developing countries especially in rural areas which constitute the mainstay of economy now use high concentrations of pesticides with the premise of enhancing their crop production (Mattews, 1992; Ayansina and Amusan, 2013). This practice raises the question of the effects of the use of higher concentrations of pesticides above that recommended by the manufacturers since it has been reported that 2-3% of applied chemical pesticides are effectively used for preventing, controlling and killing pests, while the rest persist in the soil (EPA, 2005). Most of the pesticides therefore reach the nontarget parts of the agricultural ecosystem (Avansina and Amushan, 2013) and compromise the quality of soils, air and continental and coastal water bodies (Surekha et al., 2008).

Soil microorganisms are the most abundant of all the biota in the soil and are responsible for driving nutrient and organic cycling as well as soil fertility (Vig *et al.*, 2006). Comparative studies of the numbers of bacteria and fungi in soil treated with pesticides in comparison with untreated soil are one of the fundamental approaches commonly used for the assessment of microbial response to environmental stress (Cycon and Piotrowska-Seget, 2007). Modifications in the count and activity of microorganisms may lead to upsetting the biological equilibrium of soil, which in turn depresses its fertility. Persistence of pesticides in soil has also been found to depend on their doses as well as the physicochemical properties of the soil.

Paraquat (1,11-dimethyl-4,41-bipyridinium dichloride) also known as methyl viologen is an important member of bipyridylium family of nonselective herbicides. It is a fast acting non-selective compound which destroys tissues of green plants on contact and by translocation within the 7 days (Suntres, 2002). Although, Paraquat has been banned or severely restricted in most countries, its use continues in some developing countries. Murugesani *et al.*,2010) So widespread is its use in weed control that local farmers in Nigeria regard it as a household chemical and use concentrations above the recommended rate on their farms (Ayansina and Oso, 2006).

The effect of application of high concentrations of pesticides as practiced by local farmers on the field where there are interactions with other ecological factors in Nigeria on soil physicochemical properties and microorganisms has so far received little attention. This study was therefore undertaken to investigate the effect of paraquat applied at the manufacturer's recommended rate and twice the recommended rate on soil microorganisms and physicochemical properties.

## **MATERIALS AND METHODS**

The study was conducted with two treatments replicated three times with a randomized complete block design. Each plot with mixed weeds (broad leaves and grasses) measured 6m x 3m with 3m alley and polythene nylon was used for separation between plots to prevent drift and interference was set up at the Olabisi Onabanjo University College of Agricultural Sciences Tree crop Nursery Development project site located at Ago-Iwoye, Ogun State .Nigeria. The area is located between latitudes 6<sup>0</sup>55 and 70<sup>0</sup>N and between longitudes 3<sup>0</sup>45 and 40<sup>0</sup>5E.

The commercial formulation of paraquat marketed under the brand name Gramoxone, 200g/l (Syngenta crop protection) was purchased at Ogun State Agricultural Development Project (OGADEP) store at Ijebu-Ode, Ogun State.

The treatments were as follows: post-emergence application of paraquat at the field recommended application rate (P1) at 4l/h (350 ml in 15 L sprayer), twice the recommended application rate (P2) at 8l/h (700ml in 15 L sprayer), and the untreated control (C) plot sprayed with water. Knapsack sprayer filtered with a 2.5 deflector nozzle was used for spraying.

Top soil samples (0-15 cm deep) were randomly collected using soil auger from 8-10 places from each plot before paraquat applications and subsequently at 1 week interval for a period of 8 weeks. The soil samples from different places per replication for the same weed control treatment were bulked and representative composite samples for each treatment were taken to the laboratory for analysis

The physicochemical properties of the soil samples: pH, organic carbon, total nitrogen, available phosphorus were analyzed using glass electrode pH meter method, Walkley and Black's rapid titration method, macro Kjeldahl method and Olsen's method respectively (Jackson, 1973). Cation exchange capacity in the soil was determined (Black, 1965).

Analysis of Microbial population and Identification of Microorganisms

The enumeration of the populations of bacteria and fungi in the soil was done using serial dilution technique and pour plate method on Nutrient agar (Oxoid UK®) at 10-6 dilutions and Potato Dextrose Agar (Oxoid UK®) at 10-4 dilutions respectively. Incubation was done at 35°C for 24 - 48 h. for bacteria and 72h for fungi. Major Bacterial isolates were characterized based on cultural characteristics, staining reactions and biochemical reactions. Bacteria Identification was further made with reference to the Bergey's manual of Systematic Bacteriology (1984) while fungi Identification was carried out as described by Barnett and Hunter, (1972) and by using a Laboratory Manual (Cappucino and Sherman, 2002).

Data generated from the study were subjected to One-way analysis of variance (ANOVA). Comparison of means was done with LSD at p=0.05

## **RESULTS AND DISCUSSION**

The effect of paraquat on soil physicochemical properties is shown in Table 1. There were no significant impact of paraquat usage on soil pH, total nitrogen, organic carbon, phosphorus and cation exchange capacity contents. Komal (2001) also reported that there was no alteration in pHs of the fields treated with pesticides because in soil the clay and humus fraction acts as a buffer system. The changes or variations observed in the other soil chemical properties on the field which were not significant may have been due to climatic conditions or as a consequent of mineralization of the pesticides.

Paraquat at both the recommended and twice the recommended rates resulted in reduction in bacterial and fungal populations (Fig 1 and 2). Tu and Bollen (2006) also reported that paraquat decreased both total mould and bacterial populations in Chehalis silt loam. Gradual increases in bacterial populations was observed at the fourth week of sampling which continued till the end of the sampling period while fungal populations reductions continued till the end of the sampling period (Fig 1 and 2). This trend in bacterial population was also reported by Ayansina and Oso, (2006) and Ayansina and Amusan (2013) in soil treated with herbicides under laboratory conditions and by Korpraditskul *et al.*,(1988) in a field experiment.

The initial decrease in bacterial counts observed in this study could be attributed to the toxic effects of the herbicides which are normally most severe immediately after application, when their concentrations in soil are the highest. Later on microorganisms take part in a degradation process and herbicide concentration and its toxic effect gradually decline up to half-life after which the degraded organic herbicide provides the substrate with carbon, which leads to an increase of the soil micro flora while the fluctuation in bacterial population may be attributed to nutritional and environmental changes as well as chemical pollution that takes on the field.

Fungi population in this study were more adversely affected than the bacterial population by paraquat treatment (Fig 2) which corroborates the work of Wilkinson and Lucas (2007) in which paraguat was found to be more fungi toxic than other herbicides to a range of organisms. Contrary to the above reports, Busse et al. (2001) found little evidence that repeated field applications of glyphosate is detrimental to microbial populations and processes in soil. The mean bacterial and fungal counts in the control soil were significantly (P<0.05) higher than those in the paraquat plot soils while mean bacterial count in recommended field rate of paraguat plot soil was significantly (P<0.05) higher than that of twice the recommended rate plot soil. There was however no significant differences in the mean fungal counts of both concentrations of paraguat treated soils (Table 2).

Twice the recommended rate of paraquat (P2) had higher reduction effect on soil bacterial and fungal populations (Table 2), Moorman *et al.*, (2001) and

Ayansina *et al.*, (2013) had reported that higher herbicides concentrations applications resulted in significant reduction of bacterial counts. The indiscriminate use of high concentrations of pesticides with the hope to promote effective weed and insects control (Mathews, 1992) might work for some years but will lead to loss of beneficial microorganisms which will invariably lead to loss of fertility in soils.

Presented in Table 3 is the occurrence, distribution and frequency of isolation of the major bacteria genera isolated from the control and paraquat treated soils. The microorganisms isolated in this research are those common to the natural environment (Ayansina and Amusan 2013). The herbicide at both concentrations had marked reduction effects on the occurrence and distribution of all the bacterial species in the soil. Bacillus spp. and Pseudomonas spp. were the predominant and most frequently isolated bacterial species in both the control and paraquat plots soils. Both organisms have been reported to be dominant in pesticides treated soils (Bollag and Liu 1991; Taiwo and Oso, 1997; Das and Mukherjee, 2000; Ayansina and Amusan 2013). The herbicide at both concentrations used had reduction effects on the occurrence and distribution of all the bacterial species which corroborates the earlier findings of Sakata et al., (1992) and Ayansina and Amusan, (2013) and at both rates led to the elimination of Serratia and Corynebacterium spp. The predominant and most frequently isolated fungal species in both control and treated soils were Aspergillus and Penicillium species which corroborates the work of Ayansina and Amusan (2013) in which this fungus was dominant in soil treated with herbicides. Applications of paraquat at both concentrations had marked reduction effects on the occurrence and distribution of all the fungal species in the soil with twice the recommended rate having the lowest number of isolates (Table 4).

*Bacillus* and *Pseudomonas* species help to suppress pest and pathogens as well as promote plant growth, some of these strains have been developed into fungicides, insecticides or as generic plant growth while *Aspergillus* and *Mucor* and *Rhizopus* species are involve in soil aggregation and fertility hence their continuous reduction or suppression in soil could be detrimental to plant productivity in the future (Singh and Singh, 2005).

#### CONCLUSION

This study was able to confirm that the use of paraquat at field application recommended rate and twice the recommended rate had no adverse effect on soil pH, percentage nitrogen, organic carbon, organic matter and cation exchange capacity however the herbicide suppressed microbial populations with higher concentration leading to greater inhibition and suppression of soil bacteria and soil fungi. This is detrimental to the sustainability of soil fertility. Soil fertility is determined by the presence of sufficient nutrients and a sufficient number and diversity of soil microorganisms. A reduction in microbe's number may disturb a specific process in the food web performed by an individual or group, and disrupts the different components relying upon it. Farmers in Nigeria and other developing counties need to be educated on the cautious and proper use of pesticides so as to curtail the dangers associated with indiscriminate use Continuous use of pesticides needs be monitored constantly with respect to their persistence in soil, plants and effects on soil organisms in terms of ill effects



Fig 1: Effect of paraquat on the population of total bacteria

Key: P1-Recommended rate of Paraquat, P2-x2 Recommended rate of Paraquat, CO-Control

Error bars represent standard error





Key: P1-Recommended rate of Paraquat, P2-x2 Recommended rate of Paraquat, CO-ContError bars represent standard error

Table 1: Mean values of soil physicochemical parameters in control and paraquat treated soil (pooled data).

Parameters								
Treatments	pН	N(%)	OC	Р	CEC			
CO	6.13±0.43a	0.18±0.19	1.49±1.81	4.31±2.14	4.85±1.76			
P1	6.07±0.44	0.19±0.20	1.71±2.23	4.65±1.35	4.62±1.33			
P2	6.02±0.58	0.16±0.15	1.14±1.32	5.07±2.59	4.92±1.81			
Mean	6.07	0.18	1.45	4.68	4.80			
LSD <sub>0.05</sub>	n.s.	n.s.	n.s.	n.s.	n.s.			

aMean±s.d.; n.s.: no significant.

Values are means compared by LSD at the 5% Level (P=0.05)

Key: P1- Recommended rate of Paraquat, P2- X2 Recommended rate of Paraquat, CO-Control

and toxic residues. Agricultural practices that enhance soil sustainability and management such as the incorporation of carbon rich organic matter like compost and other organic amendments into the soil which can serve as sources of energy and nutrients for soil organisms, planting of cover crops and weed suppressive crops, mixed farming in which leguminous crops are incorporated should be encouraged

Table 2: Comparative effects of paraquat on bacterial and fungal populations

Microbial Group	Herbicide	Mean
ProtorialCount(x106afu/a)	D1	0.00±0.04b
BacteriarCount(x100cru/g)	P2	7.60±0.03a
	Control	11.9±0.03c
	Mean	9.80
	LSD <sub>0.05</sub>	S
Fungal Count (x104cfu/g)	P1	1.67±0.141a
	P2	1.65±0.13a
	Control	3.76±0.16b
	Mean	2.36
	LSD	S

aMean±s.d.; s: significant.

Values are mans compared by LSD at the 5% Level (P=0.05)

Key: P1- Recommended rate of Paraquat, P2- X2 Recommended rate of Paraquat, CO-Control

Table 3: Effect of paraquat on the occurrence, distribution and frequency of isolation predominant genera of bacteria in control and treated soils

Microorganism	No of Isolates Treatments		
	СО	P1	P2
Bacteria	Number and frequencies	Number and frequencies	Number and frequencies
Bacillus sp.	22 (31.9%)	16 (34.8%)	13 (31.0%)
Pseudomonas sp.	16 (23.2%)	10 (21.7%)	9 (21.4%)
Micrococcus sp.	8 (11.6%)	7 (15.2%)	6 (14.3%)
Staphylococcus sp.	7 (10.1%)	5 (10.9%)	6 (14.3%)
Streptococcus sp.	7 (10.1%)	4 (8.7%)	3 (7.1%)
Proteus sp.	5 ( 7.2%)	3 (6.5%)	4 (9.5%)
Corynebacterium sp.	1 (1.4%)	0 (0.0%)	0 (0.0%)
Klebsiella sp.	2 (2.9%)	1 (2.2%)	1 (2.4%)
Seriatia sp	1 (1.4%)	0 (0.0%)	0 (0.0%)
Total	69	46	42

Key: P1- Recommended rate of Paraquat, P2- X2 Recommended rate of Paraquat, G1- Recommended rate of Glyphosate, G2- X2 Recommended rate of Glyphosate, CO-Control

Table 4: Effect of paraquat on the occurrence, distribution
and frequency of isolation predominant genera of fungi in
control and treated soils

Microorganism	No of Isolates Treatments			
	СО	P1	P2	
Fungi	Number and	Number and	Number and	
	frequencies	frequencies	frequencies	
Aspergillus sp	16 (39.0%)	9 (40.9%)	8 (44.4%)	
Penicillum sp	7 (17.1%)	5 (22.7%)	2 (11.1%)	
Rhizopus sp	4 (9.8%)	4 ((18.2%)	3 (16.7%)	
Mucor sp	7 (17.1%)	3 (13.6%)	1 (5.6%)	
Fusarium sp	7 (17.1%)	1 (4.5%)	4 (22.2%)	
Total	41	22	18	

Key: P1- Recommended rate of Paraquat, P2 -x2 Recommended rate of Paraquat, CO-Control

## REFERENCES

- Ayansina, A.D.V and Oso, B. A. (2006). Effect of commonly used herbicides on soil microflora at two different concentrations. *African Journal Biotechnology*, 5(2): 129-132.
- Ayansina, A.D.V and Amusan, O. A. (2013). Effect of higher concentration of herbicides on bacterial populations in tropical soil. *Unique Research Journal of Agricultural Sciences*, 1: 001-005.
- Barnett, H. L and Hunter, B. (1972). Illustrated Genera of Imperfect Fungi. Minapolis: Burgress Publishing Company.
- Bergey, H., Krieg, N. R and Holt, J. G. (1984). Bergey"s manual of systematic bacteriology. Baltimore.
- Black, C. A. (1965). Method of Soil Analysis Part 2. Agronomy Monograph No. 9. Macluso, Wisconsin : American Society of Agronomy Inc. Publisher.
- Bollag, J.M and Liu, S. (1991). Microbial transformation of the herbicide Metoclachlor. *Diversity of Environmental Biogeochemistry*, 6: 89-90.
- Busse, M. D., Ratcliff, A.W., Shestak, C.J. and Powers, R. F. (2001). Glyphosphate toxicity and the effects of long-term vegetation control on soil microbial communities. *Soil Biology and Biochemistry*. 33: 1777-1789.
- Capuccino, J. G. and Sherman, N. (2002). Microbiology: A Laboratory Manual 6th ed. San Francisco: Benjamin Cumming.
- Cycon, M. and Piotrowska, S. (2007). Effect of the selected pesticides on soil microflora involved in organic matter and nitrogen transformation: Pot experiment. *Polish Journal of Ecology*, 55: 207-220.
- Das, A.C. and Mukherjee, D. (2000). Soil application of insecticides influences microorganisms and plant nutrients. *Applied Soil Ecology*, 14:55–62.
- Environmental Protection Agency (EPA) (2005). Pesticides Information Database. Washington, D.C.
- Jackson, M. L. (1973). Soil Chemical Analysis. New Delhi, India, Pp 498.
- Komal, V., Singh, D. K., Agarwal, H. C., Dhawan, A. K., and Prem, D. (2001). Insecticide residues in cotton crop soil. *Journal of Environmental Science & Health*, 36(4): 421-434.
- Korpraditskul, V., Jiwajinda, S., Korpraditskul, R., Wicharn, S. and Ratanagreetakul, C. (1988). Side Effects of Three Herbicides on Soil Microorganism. *Kasetsart Journal of National Science*, 22: 54-66.
- Mathews, G. A. (1992). Pesticide Application Method– 2nd Ed. Essex-UK: Longman Scientific and Technical, Longman Group
- Moorman, T. B., Cowan, J. K., Arthur, E.L. and Coats, J. R. (2001). Organic ammendments to enhance herbicide biodegradation in contaminated soils. *Biology of Fertile Soils*, 33:541–545.
- Murugesan, A. G., Jeyasanthi T. and Maheswari S. (2010). Isolation and characterization of cypermethrin utilizing bacteria from Brinjal cultivated soil. *African Journal of Microbiology Research*, 4 (1): 10-13.
- Sakata, S., Mikami, N. and Yamada, H. (1992). Degradation of pyrethroid optical isomers by soil microorganisms. *Journal of Pesticide Science*, 17: 181–189.
- Singh, B. K. (2008). Biodegradation and Bioremediation of Pesticides in Soil: Concept, Methods and Recent Developments. *Indian Journal of Microbiology*, 48:35-40.
- Singh, J. and Singh, D. K. (2005). Bacterial azotobacter, actinomycetes and fungal population in soil after diaziron imidacloprid and lindane treatments in groundnut (*Arachis hypogaeal*) fields. *Journal of Environmental Science Health*, 40(5): 789-800
- Stanley, H. O, Maduike, E. M and Okerentugba, P. O. (2013). Effect of herbicide (atrazine and paraquat) application on soil bacterial population. *Sky Journal of Soil Science and Environmental Management*, 2(9): 101 - 105
- Suntres, Z. E. (2002). Role of antioxidants in paraquat toxicity. Toxicology, 180: 65-77.
- Surekha, R. M., Lakshmi, P. K. L., Suvarnalatha, D., Jaya, M., Aruna, K. Narasimha, G. and Venkateswarlu, K. (2008). Isolation and characterization of a chlorpyrifos degrading bacterium from agricultural soil and its growth response. *African Journal Microbiology Research*, 2: 26-31.
- Taiwo, L. B. and Oso, B. A. (1997). The Influence of Some Pesticides on Soil Microbial Flora in Relation to Changes in Nutrient Level, Rock phosphate solubilization and release under Laboratory Conditions.
- Agriculture, Ecosystems and Environment, 65: 59-68. Tu, C. M. and Bollen, W. B. (2006). Effect of paraquat on microbial activities in soils. *Weed Research*, 8 (1): 28-37.
- Vig, K., Singh, D.K., Dhawan, A.K. and Oureja, P. (2006). Soil Microorganisms in cotton fields sequentially treated with insecticides. *Ecotoxicology and Environmental Safety* 69: 263-276.
- Wilkinson, V and Lucas, R. L. (2007). Effect of herbicides on the growth of soil fungi, *New phytologist Journal JSTOR*, 168 (3): 709-719.





CHEMICAL SCIENCES

## PERCENTAGE ANTIOXIDANT ACTIVITY OF SOME PLANT EXTRACTS IN LINOLEIC ACID PEROXIDATION SYSTEM USING THIOCYANATE METHOD

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#### ABSTRACT.

Total Antioxidant Activity (TAA) by thiocyanate (-SCN) method was used to assay antioxidant activity of experimental wistar rats treated with oil extracts from kernels of Mangifera indica, (Mi); Irvingia gabonensis, (Ig) and Irvingia wombolu (Iw). All the oil extracts were found to exhibit high antioxidant activity of between 61 - 93% irrespective of time of investigation. The results for percent inhibition of lipid peroxidation of all fractions were found to be significant (p < 0.05) and the order was found to be I. wombolu (93.71±0.57%) in 24hours followed by M. indica (79.17±0.9%) in 36hours and I. gabonensis fraction (92.46±0.53%) in 60hours confirming I. wombolu as a superior radical scavenger compared to the other extracts.

Keywords: Thiocyanate, Mangifera, Irvingia, Total Antioxidant, Inhibition.

## INTRODUCTION.

The role of free radicals and tissue damage in disease such as atherosclerosis, heart failure, Neurodegenerative disorders, aging, cancer, diabetes mellitus, hypertension and severalother disorders are becoming increasingly recognized (Flora., 2007). Reactive oxygen species (ROS), as well as reactive nitrogen species (RNS), are products of normal cell metabolism, environmental stresses, and UV irradiation and they are well recognized for playing a dualrole as both deleterious and beneficial species. since they are either harmful or beneficialto living systems (Valko et al., 2004). Therefore search for natural antioxidants has received much attention and efforts have been made to identify natural compounds that canact as suitable antioxidants to replace synthetic ones (Khan et al., 2010). Currently there is growing interest towards natural antioxidants of herbal resources. Epidemiological and in vitro studies on medicinal plants and vegetables strongly supports this idea that plants are capable of exerting protective effects against oxidative stress in biological systems (Souri et al., 2008).

Determination of the antioxidant activity is one of the ways to biologically and nutritionally evaluate the quality of a fruit. It has been proven that antioxidant activity depends on the type of phenolics present in the fruit, as some phenolic compounds exhibit higher antioxidant activity than others. It is assumed that the ability of plant polyphenols to scavenge reactive oxygen radicals participates in the protective mechanism of plants. Due to the chemical diversity of antioxidants present in fruit, their strictly defined content is unavailable. In spite of the fact that total amount of antioxidants in various fruit types need not to represent the total antioxidant capacity, almost all phenolic compounds in fruits demonstrate some antioxidant activity. However, detection of therapeutically active components in a biological matrix is a very complex procedure, and their determination differs in individual studies (Kizek et al 2010).

Mangoes belong to the genus *Mangifera*, consisting of numerous species of tropical fruiting trees in the flowering plant family *Anacardiaceae*. The mango is indigenous to India but cultivated in many tropical and subtropical regions and distributed widely in the world (Omale, 2014). Mango is one of the most extensively exploited fruits for food, juice, flavor, fragrance and color (Maisuthisakul, 2008). In several cultures, its fruit and leaves are ritually used as floral decorations at weddings, public celebrations and religious ceremonies.

*Irvingia* is a genus of African and Southeast Asian trees in the family *Irvingiaceae*, sometimes

known by the common names wild mango, African mango, or bush mango. They bear edible mangolike fruits, and are especially valued for their fat and protein rich nuts, known variously as ogbono, etima, odika, or dika nuts. The subtly aromatic nuts are typically dried in the sun for preservation, and are sold whole or in powder form. They may be ground to a paste known variously as dika bread or Gabon chocolate. Their high content of mucilage enables them to be used as thickening agents for dishes such as ogbono soup.

The focus of this study is aimed at determining the percentage antioxidant activity of the conventional mango (*Mangifera indica*) and wild mango (*Irvingia* species) kernel oil extracts in a linoleic acid peroxidation system using the thiocynate method.

## MATERIALS AND METHODS

Fruits of mango (Mangifera indica) and varieties of wild mango (Irvingia gabonensis and wombolu)) were plucked from trees at Kogi State University Anyigba, Nigeria. The fleshy pulp was peeled using a stainless steel knife to release the seeds which were then sun-dried for a week. The shells were then cracked manually to obtain the kernels which were creamy and bi-lobed. The kernels were then ovendried at 105°C to storable moisture content and finally ground to powder in readiness for experimentation. Sodium carbonate, linoleic acid,Tween-20, used were manufactured by BDH Chemicals in UK. Other solvents and reagents used in this study were of analytical grade and available commercially.

Mango kernel powder (100g) and each of the wild mango species were placed in a cellulose paper (thimble), placed in the extraction chamber and extracted using ethanol as solvent. The antioxidant activities in a linoleic acid emulsion system of the samples were determined using the thiocyanate method as modified by Maisuthisakul, (2011). Samples (10mg) were dissolved in 10ml of water and various concentrations (50, 100, 250 and 500µg/ml) were prepared and added to the linoleic acid emulsion system and homogenized. {The emulsion system was prepared by mixing 0.2804g linoleic acid, 0.2804g tween 20 and 50ml of 40mM potassium phosphate buffer (pH 7.0)}. The emulsion system (2.5ml), 2ml of the phosphate buffer was added to prepared sample solutions. The final volume of the emulsion system was adjusted with the phosphate buffer to 5ml. The control was prepared by mixing 2.5ml of the emulsion system and 2.5ml of the phosphate buffer. The reaction mixture was incubated in the dark at 37°C in a glass flask in the oven for 60 hours. The incubated samples (1ml) was removed at 12 hour intervals, 0.1ml 20mM FeCl, and 0.1ml 30% NH4SCN were added. After the

mixture was rested for three (3) minutes, the peroxide value was determined by monitoring absorbance at 500nm until the absorbance of control reached the maximum. The degree of linoleic acid peroxidation (total antioxidant activity as percentage inhibition) was calculated using the following formula:

Where Ac is the absorbance of control and As is absorbance of sample that gave maximum absorbance of control.

The results of this investigation are presented as mean $\pm$ SD of three replicate measurements. Statistical analyses among treatments were determined at the significance level of p<0.05.

## **RESULTS AND DISCUSSION**

Tropical and subtropical fruits such as mango, guava, papaya and many others are well known in the world and the scientific basis for their consumption is well founded (Leontowicz *et al.*, 2007). *Mangifera indica* and *Irvingia* species have beneficial uses that make the investigation more imperative. From these results, it could be noticed that Mango oil (Mi) yielded about 25% oil while the Irvingia oils were in the range of 14 - 34%. This indicated that the *Irvingia gabonensis* variety particularly, was a richer oil seed that the Mango seed. Matos *et al.*, (2009) also reported that Irvingia seed kernels are richer in lipids than other conventional oil seeds such as cotton seeds, soybean, rapeseed and palm fruit.

The result of percentage antioxidant activity of oil extracts within a sixty (60)-hour incubation period is presented in Table 1 and Time versus Activity relationship is shown in Figure 1. All the extracts exhibited high antioxidant activity of between 61 - 93% irrespective of time of investigation. Furthermore, Irvingiagabonensis inhibited linoleic acid peroxidation the most when compared with the other oils as seen from Table 2. This was ascribed to a proportion of about 11% polyphenolic constituents in the testa (Arogba, 2001).

Ferric thiocyanate method was originally designed formeasuring lipid peroxide content, whereby the end point measure is the amount of  $Fe^{2+}$  that is oxidized to  $Fe^{3+}$  by lipid peroxides. Thus, a high percentage is indicative of high peroxidation during emulsion incubation and by extension, a high antioxidant activity. The  $Fe^{3+}$ -thiocyanate complex produces adeep red color, which is detectable at 500 nm and the thicker the colour, the higher the absorbance. Theadvantage of using ammonium thiocyanate over othercoloring reagents is that binding of iron by thiocyanate ionis specific to  $Fe^{3+}$  only, and that the  $Fe^{3+}$ -thiocyanatecomplex

produces a single absorbance peak at 500 nm.Results obtained from FTC assay revealed that theextracts carry the antioxidative potentialfor chain-breaking inhibition of lipid peroxidation.The ferric ions form chromophores when complexed to thiocyanate,which can be measured by spectrophotometry (Eymard and Genot, 2003)

$$LOOH + Fe^{2+} \rightarrow Fe^{3+} + LO\bullet + OH^{-} \qquad (1)$$
  
Fe^{3+} + [SCN]^{-} + 5H\_2O \rightarrow [Fe(NCS)(H\_2O)5]^{2+} \qquad (2)

From this result, the total antioxidant activity in Irvingia gabonensis was significantly (p<0.05) higher than in Mangifera indica. The result also showed that the oxidation of linoleic acid was remarkably inhibited by all the extracts studied. The data revealed, inhibition percentage of lipid peroxidation was high in the order of I. wombolu (93.71±0.57%) >I. gabonensis fraction (92.46±0.53%) >M. indica  $(79.17\pm0.9\%)$ . The data revealed that the I. wombolu and I. gabonensis fractions showed potent inhibition of lipid peroxidation formed during linoleic acid system. The high peroxidation scavenging effect may be due to the high contents of phenolic compounds or radical scavengers involved in the extracts (Duh et al., 1999) which can terminate the peroxidation chain reactions easily (Soares et al., 1997) and quench reactive oxygen or nitrogen species, thereby inhibiting the oxidation of lipids and other biological molecules (Morton et al., 2000).

The results for percent inhibition of lipid peroxidation of allfractions were found tobe significant (p < 0.05). When effect of time of incubation was considered, the order was found to be I. *wombolu* (93.71±0.57%) in 24hours followed by M. *indica* (79.17±0.9%) in 36hours and I. *gabonensis* fraction (92.46±0.53%) in 60hours confirming I. *wombolu* as a superior radical scavenger compared to the other extracts. It was also noticed from Table 2 that the kernel types exhibited a pattern from oil extracted to inhibition of peroxides: the higher the percentage of oil extracted, the higher the percentage antioxidant.

## CONCLUSION

This study supports the contention that traditional medicines remain a valuable source in the potential discovery of natural product pharmaceuticals. Significant antioxidant activity shown by extracts, provide a scientific validation for the traditional use of these plants. Hence, it was concluded that these fractions are rich in strong antioxidants and potent radical scavengers. These fractions are potentially valuable sources of natural antioxidants and bioactive materials, which would be expected to increase shelf life of foods and fortify against peroxidative damage in living systems in relation to aging and carcinogenesis.

#### REFERENCES

- Abdalla, A. E. M., Saeid, M. D., Eman H. E. A and Rehman, M. E (2007). Egyptian mango by-product: Compositional quality of mango seed kernel. *Food Chemistry*. 103: 1134 – 1140.
- Arogba, S. S (1997). Physical, chemical and functional properties of Nigerian mango (*Mnagifera indica*) kernel and its processed flour. *Journal Science and Food Agriculture*. 73: 321 328.
- Arogba, S. S (2001). The effect of testa on the physico-chemical properties, browning index and functional properties of wild mango (*Irvingia gabonensis var. gabonensis*) kernel. *Inter-World Journal Science* and Technology.1(1): 159 – 167.
- Duh, P.D., Tu, Y.Y. and Yen, G.C. (1999). Antioxidant activity of water extract of Harn jyur (*Chrysanthemum morifolium* Ramat). Lebensmittel-Wissenschaft Technologie.;32:269-277.
- Dzeufiet, D. P. D., Ngeutse, D. F., Dimo, T., Tedong, L., Ngueguim, T. F., Tchamadeu, M. C., Nkouambou, N. C., Sokeng, D. S and Kamtchouing, P. (2009). Hypoglycemic and hypolipidemic effects of *Irvingia gabonensis (Irvingiaceae)* in diabetic rats. *Pharmacologyonline*2: 957 962.
- Ekpo, I. W., Amor, I. D and Morah, F. N. I (2007). Seed oils and nutritive studies on the seeds of *gabonensis* and wombolu varieties of Irvingia gabonensis. The Nigerian Academic Forum. Volume 13 No 1.
- Flora, S. J. (2007). Role of free radicals and antioxidants in health and disease. Cell Mol. Biol.53:1-2.
- Khan, M.A., Shahwar, D., Ahmad, N., Khan, Z. and Ajaib, M. (2010). Chemical constituents of *Carissa opaca* extracts and their evaluation as antioxidants and preservatives in edible oils. *Asian J. Chem.* 22:379-388.
- Maisuthisakul, P. (2008). Antiradical scavenging activity and polyphenolic compound extracted from Thai mango seed kernels. *Asian Journal of Food and Agro-Industry*. 1(2):87 96.
- Matos, L., Nzikou, J M., Matouba, V N and Pandou-Yembe, V N. (2009). Studies of Irvingia gabonensis seed kernels: Oil Technological Applications. *Pakistan Journal of Nutrition*.8(2): 151 157.
- Matsinkou, R S., Ngondi, J L., Kuate, D., Mbofung, C and Oben, J E. (2012). Antioxidant and antihyperglycemic potential of pulp extracts of *Irvingia wombolu* fruits. *Biology and Medicine*. 4(1): 10–19.
- Morton, L.W., Abu-Amsha, C. R., Puddey, I.B. and Croft, K.D. (2000). Chemistry and biological effects of dietary phenolic compounds: relevance to cardiovascular disease. *Clin. Exp. Pharm. Phys.*;27:152-159.
- Ngondi, J., Oben, J. and Minka, S. (2005). The effect of *Irvingia gabonensis* seeds on body weight and blood lipid of obese subject in Cameroon. *Lipids in Health and Disease*. 4:12.
- Omale, J. (2014). Antioxidant activity and lipid profile of wistar rats fed with *Mangifera indica, Irvingia wombolu and Irvingia gabonensis* kernel oil extracts. M. Sc Thesis, Kogi State University, Anyigba Nigeria.
- Soares, J. R., Dins, T.C.P. and Cunha, A.P. (1997). Antioxidant activity of some extracts of *Thymus zygis*. *Free Radical Res*.;26:469-478.
- Souri, E., Amin, G., Farsam, H., Jalalizadeh, H. and Barezi, S. (2008). Screening of thirteen medicinal plant extracts for antioxidant activity. *Iran. J. Pharm. Res.*7:149-154.
- Valko, M., Izakovic, M., Mazur, M., Rhodes, C.J. and Telser, J. (2004). Role of oxygen radicals in DNAdamage and cancer incidence. *Mol Cell Biochem*.266:37-56.





# EARTH SCIENCES

## PALYNOFACIES AND THERMAL MATURITY ANALYSIS OF BZ-1 AND BZ-2 WELLS, NIGER DELTA BASIN, NIGERIA.

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#### ABSTRACT

The palynofacies and thermal maturity analysis have been carried out on one hundred and twenty composited ditch cuttings samples from BZ-1 and BZ-2 wells, offshore Niger Delta, Nigeria. The hydrocarbon potential of these sediments recovered from both wells were estimated on the basis of palynofacies analysis and thermal alteration index (TAI) values based on the palynomorphs (spore or pollen) colouration. The palynofacies analysis of the two wells reveals rich organic matter preservation, with amorphous organic matter and phytoclasts constituting the bulk of the total organic matter and low palynomorphs. The relative ratio and distribution of the palynofacies across the wells shows that the formation is gas laden and very little oil prospect. The thermal maturity deduced from the optical examination of the organic matter revealed that well BZ-1 sediments are immature while those of well BZ-2 are immature to slightly mature (TAI between - 2 and + 2 and SCI between 3 and 5). The lithological description of the analyzed sections of both wells revealed a clastic sequence composed of alternating sand and shale sequences with accessory shell fragments, carbonaceous detritus, ferruginous materials, mica flakes, pyrites and rare glauconite.

Keywords: Palynofacies, Thermal maturity, hydrocarbon potential and Niger Delta.

## INTRODUCTION

The Niger Delta is a major hydrocarbon producing basin in Nigeria where intensive exploration and exploitation activities have been on since early 1960's owing to the discovery of commercial oil in Oloibiri-1well in 1956 (Reijers et al., 1996). Since then, exploration and production activities have moved from the near shore into the shallow-water offshore and presently into the deep-water. This region has been described as the seat of oil and gas production in the country and placing the country as one of the top ten leading oil producing nation in the world is no longer news (Egberongbe et al., 2006). The tremendous increase in the world population over the last two decades and high industrial development has led to increase demand of petroleum products. The increasing demand of these products has significantly affected the pricing in the world market. Although, the recent shale oil discovery coupled with

the economy recession have drastically reduced the price of the petroleum products. With the reduced price, the cheaper way of hydrocarbon assessment and discovery in ageing field and new frontier basin has preoccupied the geologist and engineers. Thermal maturity and paleoenvironment of deposition are very important parameters in evaluating the hydrocarbon potentials of source. Among the multi-tools used in assessing these parameters, palynofacies analysis is a very cheap and effective method of optical screening and semi qualitative control for geochemical bulk rock parameters. Hence, this study isaimed atevaluating the hydrocarbon potentials of the studied sections (BZ-1 and BZ-2)using palynofacies and to establish the paleoenvironment of deposition. The study area fall within the shallow offshore Niger Delta (Fig 1), the coordinate and the name of the wells were not made available for confidential reasons by the oil companies.





#### **MATERIALS AND METHODS**

The present studies is based on one hundred and twenty (120) ditch cuttings ranging in depth from 2105m to 3305m and 1000m to 2220m samples from BZ-1 and BZ-2 wells, shallow offshore, Niger Delta. About fifty grams of each sample were washed with soap and water through 63 micron mesh sieve and oven dried at about 80°C. Lithologic descriptions were undertaken by observation of the samples under the Olympus stereoscopic microscope and by considering the textural parameters. The textural parameters been considered are grain size, sorting, colour, lithology, post depositional effects such as ferruginization, presence of accessory minerals and fossils contents. The samples were tested with 10% hydrochloric acid to determine the presence of calcareous materials. For the palynofacies preparation, twenty five grams of eachsample were subjected to maceration and dissolved with hydrochloric acid (HCl) and hydrofluoric acid (HF). The organic matter was separated in heavy mineral (ZnBr<sub>2</sub>) solution(Faegri and Iversen1989). The organic residue were not oxidized or sieved in order to preserve the organic matters present. A slide per sample was scanned with transmitted light LeitzOrtholux II microscopeunder various magnifications (X250, X400 and X1000) and compared with the standard spore comparator

(Traverse, 2007). In this work, three main groups of

morphological constituents can be recognized within the organic assemblages: Phytoclasts, Palynomorphs, (sporomorph and phytoplankton) and Amorphous Organic Matter - AOM (Tyson 1993, 1995).

#### **RESULTS AND DISCUSSION**

The Lithology of Well BZ-1 was sampled from 2105 m to its total depth of 3300 m. Three lithologic units were found which are shale, sandy shale, shaly sand and sand. The well is dominated with thick shales at 2225 - 2305m, 2765 - 2825m and 2905 -3005m which are synonymous to the Lower Agbada Formation. The sands were milky white, pinkish and light brown in colour. They are moderately sorted, medium grained and subangular to subrounded in shape. The shale shows alternation of light grey to grey and black. The shale is moderately hard, bulky and fissile to sub fissile. The formation has some accessories minerals like glauconite, pyrite, mica specs, ferruginized and carbonaceous materials. The depths 2605 - 2665m, 2765 - 2825m, 2905 -3025m and 3125 - 3165m were characterized with the presence of shell fragment, pyrite and spec of mica which suggest a deposition in a relatively low energy environment, partially oxygenated (inner to middle shelf). The basal part of the formation was characterized by ferruginised and carbonaceous material, pyrite and few glauconite which suggest a partially oxygenated to oxygenated environment and (proximal coastal to inner shelf). Also, when the shale was tested with 10 % hydrochloric acid it shows effervesce which confirm the presence of calcium carbonate (CaCo<sub>2</sub>) in the shale at 2325 - 2345 m, 2705 – 2725 m, 2665 – 2685 m and 2365 – 2385 m. Lithology of Well BZ-2 was sampled from 1000m to its total depth of 2220m. Four lithologic units were found which are shale, sandy shale, shaly sand and sand. The alternation of shale and sandstone was conspicuous in the well. The upper section of the formation in the well BZ-2 is dominated by shaly sand and shale. Distinct sand formations were found at interval 1560m to 1600m. The sand units of the upper section were mostly white to locally pinkish in colour. The sands are medium grained, subrounded to round in shape and moderately sorted. The shale shows alternation of light grey to grey and dark grey. The shale is moderately hard and fissile to sub fissile. The shale is dominated with accessories minerals like pyrite, glauconite, mica specs, carbonaceous materials and ferruginized materials. The upper section of the formation from 1000 - 1260 m has a persistence of accessory minerals like pyrite, carbonaceous and few occurrence of shell fragment, CaCo<sub>3</sub>, ferruginious material. This is probably a quiet, low energy and partially oxygenated environment (inner to middle shelf). The middle to lower section of the formation from 1260 –1920mhas persistence of occurrence of ferruginious material, carbonaceous material and few pyrite and glauconite. This is probably a low

energy, oxygenated environment (proximal (fluvial) to marginal). The calcium carbonate was also found at 1020 – 1040m, 1060 – 1080m and 1440 – 1460m. Palynofacies analysis involves the identification of Palynomorphs, plant debris and amorphous particles, their absolute and relative proportion, size spectra and state of preservation (Combaz 1964, 1980). Palynofacies can help not only to establish the depositional environment but also to determinate the hydrocarbon source potential and assessment of thermal maturity of the host sediments. In this work, three main groups of morphological constituents can be recognized within kerogen assemblages: phytoclasts, Palynomorphs, (sporomorph and phytoplankton) and Amorphous Organic Matter - AOM (Tyson 1993, 1995). The different types of organic matter and their frequency variation patterns as revealed in the studied section of Agbada Formation is depicted in the Fig. 2 and 3.



Fig. 2: Percentage relative abundance of Amorphous organic matter (A%)Phytoclasts

(PHYTO%) and Palynomorph (PALY%) in well BZ-



Fig.3: Percentage relative abundance of Amorphous organic matter (A%)Phytoclasts

(PHYTO%) and Palynomorph (PALY%) in well BZ-2.

Phytoclasts are pieces of plant derived and structured organic material (Tyson, 1993). In this research, they are divided into three categories: opaque organic material (charcoal), brown translucent material and cuticles. Opaque organic material is made up of either charcoal or biochemically oxidized wood. It originates from the oxidation of organic material, either during forest fires, repeated degradation or thermal maturation. This is represented between average to high percentage of the total organic matter in the both wells (BZ-1 and BZ-2) studied, i.e. 45-70% (Fig.2 and Fig.3). It mainly contributes forgaseous hydrocarbons.

Amorphous Organic Matter (AOM) can have either a terrestrial or aquatic origin. Terrestrially, higher plants can secrete AOM as intra-/extra-cellular resins or decomposition of higher plants (Tyson, 1993). Aquatically, faecal pellets from zooplankton, aggregates of flocculated dead organic matter (DOM) or bacteria can form AOM (Tyson, 1993). AOM is recognizable by its unstructured appearance. It is usually grey, translucent and can have a bubbly texture. The frequency of this organic matter is quite high in the studied sections of the wells and the range varies from 18–80% (Fig.2 and Fig.3). Amorphous organic matter is considered to be anexcellent source for liquid hydrocarbons.

Palynomorphs are all organic microfossils, either plant or animal derived. They include spores and pollen; acritarchs and algae remains, including dinoflagellate cysts. Spores and pollen are the terrestrial component of this category and knownto be rich in lipids, which contribute mostly to liquid hydrocarbon. The frequency of spores and pollen is quite low and the range varies from 1-10% in the studied wells (Fig.2 and Fig.3).

## Hydrocarbon Source Rock Evaluation

The optical assessment of the studied samples was done by observing the colour change of the palynomorphs due to the effect of temperature and the maturity stage of the studied wells was determined from the colouration. To access the Thermal Alteration Index (TAI) and the Spore Colour Index (SCI) of the studied samples, the colour of spores and pollen grains appearance has been chosen to show the result of temperature effect on its colour changes. Also cuticles, phytoplankton and amorphous organic matters were used in the present study for determining TAI values in the absence of palynomorphs. The TAI and SCI values for the studied slides have been determined using transmitted light microscopy and according to the TAI and SCI scale proposed by Traverse (2007).

# Hydrocarbon Potential and thermal Maturity of Wells

The different types of palynofacies (Organic Matter) and their frequency variation patterns at various depths of the well sections were used to reveal the hydrocarbon potentials of the sediments.

## Well BZ-1

<u>2105m – 2425</u>mrepresents the top most part of the section in the well and shows a very high percentage of phytoclast (between 45 – 90%), average AOM (11 – 55%) and a very low palynomorphs (0 – 5%). According to Tyson (1993), this palynofacies distribution is synonymous to marginal dysoxic - anoxicpaleoenvironment and the organic matter composition (Kerogen III type) are prone to gas production.

<u>2425–3265</u> mrepresents the mid to base of the section studied in the well and shows average percentage of phytoclast (14 – 65%), AOM (20 – 55%) and very low palynomorphs (0 – 5%). According to Tyson (1993), this palynofacies distribution is synonymous to proximal suboxic – anoxic basin paleoenvironment and the organic matter composition (Kerogen II type) are prone to gas production.

## Well BZ-2

<u>1000 – 1320</u>m represents the top most part of the section studied in the well and shows high AOM (24 - 90%), low phytoclasts (3 - 33%) and very low palynomorphs (1 - 10%). This palynofacies distribution signifies the distal suboxic-anoxic basinpaleoenvironment and the organic matter composition (Kerogen II>I type) are prone to oil production (Tyson 1993).

<u>1320 – 1840</u>m falls within the mid section of the section studied in the well and shows averagely equal percentage of phytoclasts (20 - 55%) and AOM (30 - 60%) but very low palynomorphs (1 - 8%). This palynofacies distribution is synonymous to proximal suboxic – anoxic basin paleoenvironment and the organic matter composition (Kerogen II type) are prone to oil production (Tyson, 1993).

**1840** – **1960** m is depth is close to the base of the section studied in the well and shows high percentage of AOM (20 - 90%), low phytoclasts(2 - 30%) and very low palynomorphs(1 - 8%). This palynofacies distribution signifies the distal suboxic – anoxic basinpaleoenvironment and the organic matter composition (Kerogen II>I type) are prone to oil production (Tyson 1993).

<u>1960 – 2200m</u> correspond to the base of the section and shows moderate percentage of phytoclasts (65 – 80%), moderately high AOM (18 – 38%) and low palynomorphs (1 – 10%). This facies distribution is equivalent to Tyson (1993) organic matter for marginal dysoxic-anoxic basin paleoenvironment and the organic matter composition (Kerogen III type) are prone to gas production.

## Age of the wells

Onthebasisofthestratigraphic distribution of diagnostic species and palynomorph assemblage recorded which *irregularis*, *Crassoretitriletesvanraadshooveni*, *Echiperiporitesestelae* and *Nympheaepollisclarus*.) The studied sections were been subdivided into zones based on the biozonationscheme of Germeraad *et al.*, (1968) and Evamy *et al.*,(1978) and later dated Late Miocene.

## **Thermal Maturity of BZ-1**

The palynomorphs found in the well BZ-1 shows two different colours when compared with the standard colour chart of Traverse et al., (2007). The lemon yellow colouration (TAI = -2 and SCI = 3) were found at interval 2105 - 2885m in the well (Fig.5). The golden vellow colouration (TAI = 2 and SCI =4) were found at interval 2885– 3305 m in the well BZ-1 (Fig.5). The palynomorphicolouration at these intervals indicates that the organic matters were immature. The samples with palynomorphscolour lemon yellow (TAI = -2 and SCI = 3) and golden yellow (TAI = 2 and SCI= 4) means that the organic matter in the sediments is thermally immature. It indicates the sediments have been through the later stages of diagenesis and only into the early stage of the "oil window".



Fig.5: Lithology, Age, paleoenvironment and thermal maturity for well BZ-1 (Modified from WEPCO, 1971).

## **Thermal Maturity of Well BZ-2**

The palynomorphs found in well BZ-2 shows variations three colours when compared with the standard chart of Traverse *et al.*, (2007). The lemon yellow colouration (TAI = -2 and SCI = 4) were found at interval 1000 – 1560m (Fig.6). The golden yellow colouration (TAI = 2 and SCI=4) were found at interval 1560 – 1980m. The yellow orange colouration was found at interval 1980– 2220m in well BZ-2 (Fig.6). The samples with palynomorphscolour yellow orange (TAI = +2 and SCI = 5) means that the organic matter in the sediment is thermally mature. It indicate the sediment have passed the oil window and in the first oilbirth.



Fig. 6: Lithology, Age, paleoenvironment and thermal maturity for well BZ-1 (Modified from WEPCO, 1971).

## CONCLUSION

The study integrated palynofacies and sedimentology analysis to ascertain the paleoenvironment of deposition, thermal maturity and hydrocarbon potential of the studied sections of the wells. Based on the result obtained from the lithofacies and log data interpretation, the sequence penetrated by the two studied wells was established. It was concluded that the studied intervals within the two wells 2105 – 3305m and 1000 – 2220m for well X and well Y correspond to lower units of Agbada Formation with thick shale and intercalation of sands. On the basis of the above lithofacies, coastal to marginal marine environment was proposed for the sequence penetrated by the two wells and this was supported by Short and Stauble (1967) for Niger Delta Basin.

The colour of the palynomorphs was used to determine the organic thermal maturation for both wells. *FULafia Journal of Science & Technology Vol. 2 No.1 March, 2016*  Colours were compared with Transverse (2007) scale of palynomorphcolours to determine the numerical thermal alteration index (TAI) and spore colour index (SCI) of sequence penetrated by both wells. The thermal alteration index and spore colour index of the recovered palynomorphs shows the sediment were between immature and mature (sediment have passed the oil window and in the first oil birth).

## REFERENCES

- Egberongbe, F.A.O., Nwilo, P.C., Badejo, O.T., 2006. Oil Spill Disaster along Nigerian Coastlines.5th FIG Regional Conference on Promoting land administration and good governance, Accra, Ghana.
- Evamy, D. D., Haremboure, J., Kemerling, P., Knaap, W. A., Molly, F.A and Rowlands, P.H., 1978. Hydrocarbon Habitat of Tertiary Niger Delta. American Association of Petroleum Geologist Bulletin. Vol. 62, Pp.1-39.
- Faegri, K., Iversen, J., 1989. Textbook of Pollen Analysis.Faegri, K., Kaland P.E., Krzywinski K, editors. New York: John Wiley & Sons; 328.
- Germeraad, J. H., Hopping, C. A., and Muller, J. 1968. Palynology of Tertiary sediments from tropical areas. Review of Palaeobotany and Palynology, 6, 189-348Pp.
- Reijers, T.J.A., Petters, S.W., Nwajide, C.S., 1996. The Niger Delta Basin, in: T.J.A. Reijers (ed.), Selected Chapters on Geology: SPDC corporate reprographic services, Warri, Nigeria, Pp. 103-114.

Short, K.C., Stauble, A.J., 1967. Outline of Geology of Niger Delta: AAPG Bulletin, 51: 761 – 779.

Traverse, A., 2007. Paleopalynology. Second Edition, Springer, 1-813.

- Tyson, R.V., 1993. Palynofacies analysis, in Jekins, D.G., (eds.), Applied Micropaleontology, Kluwer, Dordrecht, Pp.153-191.
- Tyson, R.V., 1995. Sedimentary Organic Matter, Organic facies and palynofacies, In Chapman and Hall, 615 P.
- WEPCO, 1971.Final Report and Composite Well Log of the Sharib-1X Borehole.Western Desert Operating Petroleum Company, Egypt.



Plate 1: Phytoclast



Plate 2: Phytoclasts



Plate 3: Amorphous Organic Matter

![](_page_71_Picture_7.jpeg)

Plate 4: Palynomorphs

![](_page_71_Picture_9.jpeg)

Plate 5: Palynofacies I.

![](_page_71_Picture_11.jpeg)

Plate 6: Palynofacies II

![](_page_71_Picture_13.jpeg)

Plate 7: Palynofacies III




## ENGINEERING

### A MORPHOMETRIC STUDY OF FIVE SELECTED DRAINAGE BASINS IN CENTRAL NIGERIA

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#### ABSTRACT

The physical parameters of a watershed have been shown to influence the hydrological response of the watersheds to storm events. They are useful in geo-hydrological, flood risk mapping, neo-tectonic and landform studies most especially in the many ungauged basins across the world. In the developed parts of the world, there are usually gauged basins nearby which can be used in ungauged basin predictions. In the less developed parts of the world, gauged basins are few and far between while accurate and reliable topographical maps of many basins are scarce. This makes flow predictions using basin morphometry an important subject in these areas. A morphometric study of five selected basins in central Nigeria was carried out. The results show that all the basins have elongated shape, are not compact and have low drainage density indicating moderate runoff potentials. Low stream density and high constant of channel maintenance affirm that the basins have a high permeability. The hypsometric curves show that a large part of the basins are at a low relief which is typical of the Guinea savannah found in central Nigeria. The implications of these results are critical in management decisions of sustainable use of these basins to improve rural livelihoods.

Keywords: Basins, Morphometry, Topography, Ungauged, Predictions

### **INTRODUCTION**

Basin Morphometry basically describes the process of measuring the external shape and physical dimensions of landforms in a watershed. Morphometric properties of a basin affectsto a large extent its hydrological responses to flood and drought (Biswas, 2014). The concentration time, which characterizes the speed and intensity of the basin's response to a rainfall event, is influenced by the different morphometric characteristics. Analysis of some basins in different parts of the world exist in literature (Pisal et al., 2013; Golekar et al., 2013; Nageswara et al., 2010; Nanda et al,., 2014; Koshak and Dawod, 2011; Nongkynrih and Husain, 2011; Pingale et al., 2012; Al-Saud, 2009; El-Bayomi, 2010) and in Nigeria (Eze and Effiong, 2010; Ajibade et al., 2010; Aisuebeogun and Ezekwe, 2013).

Morphometric properties of basins has been applied in geo-hydrological studies (Hajam, 2013), flood hazard mapping (Diakakis, 2011), neotectonic studies (Jacquesa, 2014), changing pattern of landforms (Ward, 2007) and to appraise the hydrological potential of ungauged basins (Ezemonye and Emeribe, 2013).

Runoff from a drainage basin is influenced by various physiographic and climatic factors. Climatic factors are natural occurrences usually outside man's influence. While the physiographic factors may be influenced, they generally vary only with respect to geological time and may thus be constant. Relevant basin characteristics that influence runoff include the Catchment Area, Basin Shape, Slope, geology, altitude, drainage density and stream density among others.

Quantitative assessment of hydrological variables such as precipitation, evaporation, infiltration and run off, and their use in water balance studies or in the problems of design and forecasting will only be rational when they are applied to an area with well-defined boundaries or a drainage basin. A basin is defined as the area drained by a stream or a system of connecting streams such that all the surface run off originating in this area leaves the area in a concentrated flow through a single outlet (Reddy, 2008).

This research sought to draw conclusions on the hydrological responses of some selected basins in central Nigeria based on their morphometric characteristics and make generalizations if possible.

### MATERIALS AND METHODS

Five basins were selected based on the availability of their topographical maps to a scale of 1:50,000 and to achieve some spread in central Nigeria. The basins were delineated manually and used to obtain GIS maps

of the basin. The chosen basins are shown in Table 1. Table 1: Selected Study Basins and Control Points

SN	Basin	<b>Control Point</b>	Latitude (°N)	Longitude (°E)				
1.	Oyun	Offa	8.15	4.72				
2.	Asa	Ilorin	8.50	4.55				
3.	Gongola	Dindima	10.22	10.15				
4.	Taraba	Gassol	8.52	10.46				
5.	Katsina Ala	Sevav	7.43	9.25				

The basin area is the area of a closed curve obtained by projecting the catchment boundary onto a horizontal plane whileother parameters were calculated based on methods described by Authors listed in Table 2. ER values close to 1.0 are typical of regions of very low relief (Nageswara et al., 2010). The Shape Factor (SF) is the inverse of the elongation ratio. The Unity Shape Factoris the ratio of the basin length to the square root of the basin area. Drainage Density (DD) is the total length of all stream channels per unit area of the basin. Ruggedness Number (RN) is a product of basin relief and drainage density. The Drainage Texture (DT) is the ratio of the total number of streams of all orders to the basin perimeter. Quantitative description of Drainage Texture is difficult and qualitative expressions such as coarse, medium and fine are usually applied (Matsuda, 2004).

Table 2: Morphometric Parameter CalculationMethods

SN	Parameters	Reference
1.	Circularity Ratio (CR), Elongation Ratio (ER), Stream Density (SD)	Reddy, 2008
2.	Compactness Coefficient (CC), Form Factor (FF)	Suresh, 2008
3.	Bifurcation Ratio, (BR)	Chow et al., 1988
4.	Fitness Ratio (FR), Wandering Ratio (WR), Hypsometric Curves	Seth et al, 1998
5.	Watershed Eccentricity (WE), Sinuosity Index (SI), Infiltration Number (IN)	Pareta&Pareta, 2011

#### **RESULTS AND DISCUSSIONS**

Some primary physiographic parameters of the basins under study are listed in Table 3 while other characteristics are in subsequent Tables. All the basins have Fern leaf shapes. With this shape, the times of concentration are long since the tributaries are of varying lengths. The discharges from the catchments are thus distributed over a long period. The shapes of the drainage basins as defined by the various parameters are given in Table 4 and the values obtained for the FF indicated that the basins are elongated and have flatter peak flows for shorter duration. The values of the FF will normally vary from zero (highly elongated shape) to unity (perfect circular shape) (Mishra *et al.*, 2011). The CR obtained for the basins indicated that the Taraba basin is relatively

the most circular in shape, since nearness to unity is indicative of a round basin. The CR's indicated that the basins are elongated in shape, have low runoff and a high possibility of permeable soils. This is further confirmed by the Elongation Ratios (ER). The classification index for the ER's is shown in the Table 5 (Pareta and Pareta, 2011). The Compactness Coefficients in Table 4 shows that the basins are not very compact. Values around unity are indicative of better compactness. The Unity Shape Factors for the basins are far above 1.0 which is a further confirmation that they are elongated. All these shape parameters are descriptors of peak discharge. The Shape Factor is negatively correlated with peak discharge. The average slopes of the basins are in Table 6.The DD is a useful numerical measure of landscape dissection and runoff potential. While it is a result of interacting factors controlling surface runoff, it also influences the water output from the drainage basins (Malik et al., 2011). The DD obtained in the basins are less than 2. These are categorised as low DD. Watershed are grouped into four categories on the basis of DD as in Table 7. The obtained low DD in Table 8 suggests that the basins have a high percentage of permeable sub soil and substantial vegetative cover (Nageswara et al., 2010), are resistant to erosion (Reddy, 2008) and runoff from the catchment can only be moderate (Raghunath, 2008). Overland flow in these basins is predominant and the resulting hydrograph has a slowly rising limb (Subramanya, 2002).

Table 1: Some Primary Physiographic Parameters ofthe River Catchments

S/N	Parameter	Oyun	Asa	Gongola	Katsina Ala	Taraba
1.	Area (km2)	87.2	872.9	10,537.3	11,718.4	19,590.3
2.	Perimeter (km)	52.8	152.6	469.3	665.0	600.5
3.	Average width (km)	5.8	18.5	72.1	65.6	86.1
4.	Total Relief (m)	119.8	121.9	1100.0	1400.0	1300.0
5.	Main Channel Length (km)	21.6	59.0	135.3	187.5	240.8
6.	Upper Contour Elevation (m)	396.0	488.0	1675.0	1800.0	1500.0
7.	Lower Contour Elevation (m)	290.0	381.0	455.0	100.0	120.0

#### **Basin Relief**

Basin relief parameters are given in Table 9. Drainage Texture (DT) for the basins is low (<2.5). This is indicative of a very coarse soil texture. DT has been classified into five different Textures as in Table 10. The Ruggedness Number (RN) indicates the structural complexity of the basin terrain. Basins having high RN are susceptible to erosion (Bagyaraj&Gurugnanam, 2011). The values obtained for the basins under consideration show that the Taraba river basin may be more susceptible to erosion than the others.

#### Table 2: Shape Parameters of the Basins

S/N	Parameter	Oyun	Asa	Gongola	Katsina Ala	Taraba
1.	Form Factor	0.23	0.33	0.41	0.33	0.48
2.	Circularity Ratio	0.40	0.47	0.60	0.33	0.68
3.	Elongation Ratio	0.41	0.59	0.72	0.65	0.78
4.	Compactness Coefficient	1.57	1.45	1.29	1.73	1.21
5.	Shape Factor	2.44	1.68	1.38	1.54	1.28
6.	Unity Shape Factor	2.75	1.89	1.56	1.73	1.44

Table 3: Classification Index for Elongation Ratios

ER Value	Basin Description
0.9 - 1.0	Circular
0.8 - 0.9	Oval
0.7 - 0.8	Less Elongated
0.5 - 0.7	Elongated
< 0.5	More Elongated

Table 4: Slope Parameters of the Basins

Parameter	Oyun	Asa	Gongola	Katsina Ala	Taraba
Average Slope of Main Channel (%)	0.615	0.303	0.420	0.733	0.106
Slope of Hydraulic Grade line (%)	0.475	0.242	0.483	0.901	0.111
Relative Relief (%)	0.230	0.080	0.165	0.253	0.030

Table 6: Length Comparisons for the Basins

Parameter	Oyun	Asa	Gongola	Katsina Ala	Taraba
Drainage Density (Km/ Km2)	0.313	0.286	0.34	0.316	0.292
Average Length of Overland Flow (Km)	3.19	3.50	2.94	3.16	3.42

This is however in relative terms only as the values for all basins are low. The Constant of Channel Maintenance (CM) depends on the rock type, permeability, climatic regime, vegetative cover and relief as well as the duration of erosion.

Table 7: Relief Parameters for the River Basins

Parameter	Oyun	Asa	Gongola	Katsina Ala	Taraba
Drainage Texture	0.83	1.2	0.785	0.386	0.712
Ruggedness Number	0.0407	0.0744	0.323	0.269	0.465
Constant of Channel Maintenance (Km2/Km)	3.19	3.50	2.94	3.16	3.42
Stream Density	0.066	0.071	0.084	0.063	0.068
Bifurcation Ratio	3.0	4.7	5.22	3.0	2.5
Fitness Ratio	0.38	0.40	0.394	0.345	0.391
Wandering Ratio	1.16	1.01	1.15	1.23	1.05
Sinuosity Index	1.04	1.08	1.08	1.12	1.04
Watershed Eccentricity	0.46	0.55	0.58	0.69	0.55
Infiltration Number	0.021	0.020	0.029	0.020	0.020

The obtained values in Table 9 are significant. It shows that they are under little structural disturbance and less runoff conditions. These conditions include high permeability, gentle basin slopes and low surface runoff. Lower values of this constant may *FULafia Journal of Science & Technology Vol. 2 No.1 March*, 2016

be favourable to a higher runoff. The low stream density obtained for the basins is to be expected. This is indicative of a highly permeable upper geology, low relief and high vegetative growth. Values of 3.0 and above are considered as very high (Bagyaraj&Gurugnanam, 2011).

Table	8:	Classes	of	Drainage	Textures
	<u>··</u> ·	C 1000 00	· · ·		

Drainage Texture	Description
<2	Very Coarse
2-4	Coarse
4-6	Moderate
6 – 8	Fine
>8	Very fine

Source: Pareta&Pareta, 2011

Bifurcation Ratios (BR) obtained in the analysis indicates some similarity in morphometry. The long narrow basin with high BR is expected to have attenuated flood - discharge periods. It has also been noted that low BR is an indication of a higher risk to flooding in some parts of the basin (Eze and Efiong, 2010). The basin shape analysis also shows that the rivers do not meander or wander much. This is based on the Wandering ratios and the Sinuosity Indices for the rivers as in Table 7. Of the rivers under consideration, the Katsina - Ala River has wandered more. The areas of high relief are not much in the basins. This is typical of the Guinea Savanna which is predominant in central Nigeria. Rivers having a Sinuosity of 1.5 and less are called "Sinuous" while above 1.5, they are considered as "meandering".

Infiltration rates indicates that the Gongola basin has relatively higher infiltration tendencies. For the same rainfall event and area, the Gongola river basin is likely to have a lower runoff than the others. It must however be noted that the values are low and thus the basins are likely to have high infiltration and low runoff.

Hypsometeric Curves describes the distribution of the basin area relative to height and the output obtained for each basin is shown in Figures 1 to 5.







Figure 2: Hypsometric Curve for Gongola River Basin



Figure 3: Hypsometric Curve for Taraba River Basin



Figure 4: Hypsometric Curve for KatsinaAla River Basin



Figure 5: Hypsometric Curve for Asa River Basin

The curves in all cases are concave in form. This indicates that a large part of the basins are at relatively low relief and will typically be associated with more old terrain. Some materials have been eroded from *FULafia Journal of Science & Technology Vol. 2 No.1 March, 2016* 

higher parts of the basin and deposited at the lower parts or removed completely from the basins. There may also have been an extensive erosion in the basins which widens the upland valleys. As this happens the part of the basin at low relief increases while the part of the basin at high relief decreases. It can thus be concluded that erosion may be an issue in some of the study basins.

#### CONCLUSION

Apart from a few characteristics like the Ruggedness Number, all the basins show a similar morphometry. This is an indication that the landforms and geology of central Nigeria do not vary much from location to location and the difference in the conversion of rainfall into runoff from basin to basin will depend more on land use and vegetative cover rather than on the relief properties. The hypsometric curves also show an inclination towards a similar erosion pattern and process in the basins. A complete topographical map of many basins in Nigeria are very difficult to obtain and in most cases dates back to the sixties. This study encourages the use of the properties of nearby basins where the map of a basin of interest is non-existent as has been shown above by the closeness of the characteristics of the Asa and Oyun River basins that share a common boundary.

#### REFERENCES

- Aisuebeogun, A. O., Ezekwe, I. C. (2013). Application of Basin Morphometry Laws in catchments of the South-Western Quadrangle of South-Eastern Nigeria., *Frontiers of Earth Science*, Volume 7, Issue 3, Pp 361-374.
- Ajibade, L. T., Ifabiyi, I. P., Iroye, K. A., Ogunteru, S. (2010).Morphometric Analysis of Ogunpa and Ogbere Drainage Basins, Ibadan, Nigeria.*Ethiopian Journal of Environmental Studies and Management*, Volume 3, No 1, Pp 376 – 380.
- Al-Saud, M. (2009).Morphometric Analysis of WadiAurnah Drainage System, Western Arabian Peninsula. *The Open Hydrology Journal*, Volume 3, Pp 1 – 10.
- Bagyaraj, M., Gurugnanam, B. (2011).Significance of Morphometry Studies, Soil Characteristics, Erosion Phenomena and Landform Processes Using Remote Sensing and GIS for Kodaikanal Hills, A Global Biodiversity Hotpot in Western Ghats, Dindigul District, Tamil Nadu, South India. *Research Journal* of Environmental and Earth Sciences, 3 (3), Pp 221 – 233.
- Biswas, A., Majumdar, D. D., Banerjee, S. (2014). Morphometry Governs the Dynamics of a Drainage Basin: Analysis and Implications. *Geography Journal*, Volume 2014, Pp. 1 14.
- Chow, V. T., Maidment, D. R., Mays, L. W. (1988). Applied Hydrology. McGraw Hill Book Company. ISBN 0-07-100174-3, New York, USA.
- Diakakis, M. (2011). A Method for Flood Hazard Mapping Based on Basin Morphometry: Application in Two Catchments in Greece.Natural Hazards, Volume 56, Pp 803–814.
- El-Bayomi, G. (2010).Morphometric Analysis in Esna Basin, Using Remote Sensing and GIS Techniques. US – Egypt Workshop on Space Technology and Geo-information for Sustainable Development, Cairo, Egypt, 14 – 17 June, 2010.
- Eze, E. B., Effiong, J. (2010). Morphometric Parameters of the Calabar River Basin: Implication for Hydrologic Progress. *Journal of Geography and Geology*, Volume 2, No 1, Pp 18 26.
- Ezemonye, M. N., Emeribe, C. N. (2013): Appraisal of the Hydrological Potential of Ungauged Basin using Morphometric Parameters. *Ethiopian Journal of Environmental Studies and Management*, Volume 6, No 4, Pp 376 – 380.
- Golekar, R. B., Baride, M. V., Patil, S. N. (2013). Morphometric Analysis and Hydrogeological Implication: Anjani and Jhiri Basin, Maharashtra, India.Archives of Applied Science Research, Volume 5, No 2, Pp 33 – 41.
- Hajam, R. A., Hamid, A., Bhat, S. (2013). Application of Morphometric Analysis for Geo-Hydrological Studies Using Geo-Spatial Technology: A Case Study of Vishav Drainage Basin.*Hydrology Current Research*, Volume 4, Issue 3, Pp 1 - 12.
- Koshak, N., Dawod, G. (2011). A GIS Morphometric Analysis of Hydrological Catchments within Makkah Metropolitan Area, Saudi Arabia. *International Journal of Geomatics and Geosciences*, Volume 2, No 2, Pp 544 – 554.
- Malik, M. I., Bhat, M. S., Kuchay, N. A. (2011). Watershed Based Drainage Morphometric Analysis of Lidder Catchment in Kashmir Valley Using Geographical Information System. *Recent Research in Science and Technology*, Volume 3, (4), Pp 118 126.

- Matsuda I. (2004). River Morphology and Channel Processes.*in Fresh Surface Water, [Ed. James C.I. Dooge], in Encyclopaedia of Life Support Systems (EOLSS),* Developed under the Auspices of the UNESCO, EOLSS Publishers, Oxford ,UK, [http://www.eolss.net]
- Mishra, A., Dubey, D. P., Tiwari, R. N. (2011). Morphometric Analysis of Tons Basin, Rewa District, Madhya Pradesh, Based on Watershed Approach.*Earth Science India*, Volume 4 (III), Pp 171 – 180.
- Nageswara R. K., Swarna L. P., Arun, K. P., Hari K. (2010).Morphometric Analysis of Gostani River Basin in Andra Pradesh State, India Using Spatial Information Technology. *International Journal of Geomatics and Geosciences*, Volume 1, No 2, Pp 179 – 187.
- Nanda, A. M., Ahmed, P., Kanth, T. A., Hajam, R. A. (2014). Morphometric Analysis of Sandran Drainage Basin (J & K) using Geo-spatial Technology.Earth Science India, Volume 7, No 2, Pp 55 – 66.
- Nongkynrih, J.M., Husain, Z. (2011).Morphometric Analysis of the Manas River Basin using Earth Observation Data and Geographical Information System.*International Journal of Geomatics and Geosciences*, Volume 2, No 2, Pp 647-654.
- Pareta, K., Pareta, U. (2011).Quantitative Morphometric Analysis of a Watershed of Yamuna Basin, India Using ASTER (DEM) Data and GIS.*International Journal of Geomatics and Geosciences*, Volume 2, No1, Pp 248 – 269.
- Pingale, S. M., Chandra, H., Sharma, H. C., Mishra, S. S. (2012). Morphometric Analysis of Maun Watershed in Tehri – Garhwal District of Uttarakhand using GIS. *International Journal of Geomatics* and Geosciences, Volume 3, No 2, Pp 373 – 387.
- Pisal, P. A., Yadav, A. S., Chavan, A. B. (2013). Morphometric Analysis of Bhogavati River Basin, Kolhapur District, Maharashtra, India. *IOSR Journal of Mechanical and Civil Engineering* (IOSR-JMCE), Volume 6, Pp. 1 – 8.
- Raghunath, H. M. (2008). Hydrological Principles. New Age International (P) Limited. ISBN 81-224-1825-2, Delhi.
- Reddy, P. J. R. (2008). A Textbook of Hydrology. University Science Press, India.
- Seth, S. M., Ramasastri, K. S., Rao, S. V. N. (1998). Representative Basin Studies: Morphometric Analysis of Suddagedda Basin, Andra Pradesh. *Published by the National Institute of Hydrology*, Jal VigyanBhawan, Roorkee – 247 667, India.
- Subramanya, K. (2008). Engineering Hydrology. Tata McGraw *Hill Publishing Company Limited of New Delhi*, India. ISBN 0-07-462449-8.
- Suresh, R. (2008).Land and Water Management Principles.*Standard Publishers Distributors*, Delhi, India. ISBN 81-8014-107-1.
- Ward, J. V. (2007): Changing Patterns of Land Use and Basin Morphometry: Impacts on Stream Geomorphology in the Illinois River Basin, Northwest Arkansas, 1941—2004, University of Arkansas, USA.





## ENVIRONMENTAL SCIENCES

## INFLUENCE OF KNOWLEDGE AND OTHER DECISION VARIABLES IN THE ACQUISITION OF HOUSEHOLD APPLIANCES AMONG CIVIL SERVANTS IN ABUJA METROPOLIS, NIGERIA

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#### ABSTRACT

The study surveyed the influence of knowledge of consumers in making sound priority acquisition of household appliances related to some demographic factors(social class, income, family life cycle and education qualifications) as independent variables and questions on knowledge of the respondents on purchase of household appliances as dependent variables. A structured instrument was constructed covering both independent and dependent variables. The reliability of the instrument was obtained at 0.832 Chromback alpha reliability. Convenience sampling technique was used to obtain two hundred (200) samples for the analysis. ANOVA was used for hypothesis testing of significant difference at P $\leq$  0.05. The results of the findings revealed that for both social class [sig. at 0.000] and income [sig. at 0.000] indicates that social class and income donot influence the extent of knowledge for sound priority acquisition of household appliance while family life cycle [sig. at 0.801] and educational qualification [sig. at 0.130] indicates it does. Females [sig. at 0.000] and males [sig. at 0.017] at t – critical value of 1.96 does not indicates significant difference exists among those who do research and those who donot research about household appliance before purchase to indicate sound priority acquisition. It can be concluded that social class and income does not influence consumer's sound priority in household appliance acquisition while family life cycle and educational qualification does. Also, to do research about appliance before purchase is not common to both male and female consumers. It is recommended that consumers of high social class and income may delegate assistants/associate to seek for knowledge or information on their behalf in order to enable them make adequate decision on household appliance. It is, also, recommended that they should avail themselves to internet technology for knowledge about household appliance.

Key words: Influence, Knowledge, Decision, Variables, Household Appliance, Acquisition, Civil Servant.

#### **INTRODUCTION**

The dynamics of social change in the market place especially between marketers and consumers have resulted in behaviour that questions and challenges many manufacturer's influences and practices. It is necessary to facilitate the understanding of consumer's decision - making process in order to improve on it in a beneficial way to everyone. Consumer behaviour studies individual and consumer characteristic such as the behavioral variable of internal influence like culture. subculture, locality, family, reference groups, social class, individual and market factors in an attempt to understand people's needs and wants. Social class is not only determined by income but various factors as wealth, education occupation, family roles, family life cycle and status, special skill and other characteristics (English and Leuck, 2000; Cherlin 2002; Gerald, 2004; Brown, 2009) and life styles, economic situation, education, age (Cherlin, 2002; Peng, Nicholas, Sabyosichi, 2009).

The consumer's inner and social environments are experienced at two levels. The more complex and unique level is the internalized level which includes the biological, psychological and social factor that suit the experiences of functional personal values which are the ideals, preferences and decisions of the individuals. At the collective level, virtue represents the person's standards and principles of the general society considered good and desirable. The society guides the behaviour and social values of its members' thereby controlling and promoting conformity which have significant bearing on their decision-making process and consumption patterns. Schifman and Kanuk (2009) noted that higher price indicate affordability and status, while emotional aspects become pertinent on the decision - making process. In other words, quest for social status is a factor or motivation for purchase. Similarly, Tian, Bearden, Hunter (2001) explained that the interior objects including household appliances are often used to impress others.

Household appliances include cooling, cooking, Laundry and building appliances. These are the more expensive household appliances considered as long term purchase due to their expanded services. Similar appliances are irons, toasters, scales, grinders, coffee machines, etc. Those household machines that comprise CDS and DVDs players, television sets, cameras, etc. are those equipment that make – up what the modern household desire but their acquisition is determined by the financial status of the family (Duplesis & Rousseu (1999). In developed countries these can be taken for granted but not so in Nigerian as in many

developing countries. Many Nigerian households are more likely to be equipped with rudimentary substitutes which are cheaper and more easily available and affordable (Ogboyomi, 1999).

Acquisition cannot be made without the exhibition of behaviour between different alternatives. It appears the behaviour of the consumer hinges on the limitation of knowledge/information processing abilities of consumers.Consumers' motivation and decision strategies usually differs from product to product due to level of importance or interests they entail for the consumer (Ajzen, 2001). Consumer information services, therefore, is vital to household appliance acquisition which involves having a good knowledge of the commodity to be bought to ensure its suitability for its' intended use. Advertisement is one form of consumer motivation.

Advertisements are useful information sources about what is available as well as the added details on the labels placed by the manufacturer. The knowledge of advertisementhelps in understanding the consumer wants, needs, motives and tastes. Learning may impact on what products will satisfy their needs. Thus, learning influences consumers in developing favourable/ unfavourable attitudes and beliefs towards certain products (Hopkin, 2006). Frost, (2006), opined that beliefs and attitudes does not make-up consumer brand image and affect their buying behaviour. The consumer does not always have to go through a learning process itself, rather, possibly learn from the consequences of others.

Armould, Price and Zinkman, (2004) explained that in a more dynamic sense, the individual who constitutes a most basic social group, who live together and interact to satisfy their personal and mutual needs constitute the family. The buyer behaviour is strongly influenced by its members, hence, buying roles change with change in consumer lifestyles. The stages in which the family find themselves in the course of their life cycle affect the nature of the goods and services they demand, in relation to those being marketed within the ambit and outcome of their budget on specific product (Cherlin, 2002). Family influences the consumption behaviour of its members by learning, using value, listening and watching parents' consumption decisions being made within the context of the family setting as a unit. Spouses exert different degrees of influences as they pass through different stages of the decisionmaking process. Thus, movement from information search to final decision may be minimal in case of goods and services but more profound for goods and services that are risky or have high involvement for the family (Raffé, 2004).

The psychology of the consumer is influenced FULafia Journal of Science & Technology Vol. 2 No.1 March, 2016 by his environment for example, culture, family, sign, media which is expressed by the behaviour/ attitude in thought, feelings and resource selection. The laws and public initiatives are made to persuade consumers to became more knowledgeable about personal finance decisions, become more financially competent in response to broad and complex societal trends. This involves raising awareness and self conception in the context of the social environment they live in. The interactions of the consumer inner and social environment leads to the formation of personal values and standards that guides human decisions and choices (Degenova, 2001).

Influence of the family financial status on the acquisition of household appliance have been created and supported by policy makers, businesses and communities. Through the literary educational institutions knowledge of the relationship between market specific variables and acquisition order could be used in formulating price support levels at various markets.

All consumers are subject to influence of several factors and these have an important bearing to their behaviour. The family as well as economic and cultural factors together constitutes consumer's environment. Today consumers are conscious of their rights; and want to be assured at the right quality of goods being made available at the right place and at the right time (Boschoff, Lamb, Hair, Micheal, Terblonche, and Krlopper, 2010).

The consumption patterns of consumers vary depending on the factors that are both internal and external to the individual. Consumer acquisition priority of household appliance is dedicted by varying factors that influence the behaviour of the consumer. Hitherto behaviour if not well guided will become a major concern to the general welfare of the immediate family of the individual. In recent past, consumer acquisition of goods and services has been threatened by various problem issues, such as recession, high inflation and others. These issues have directly or indirectly shaped consumption and expenditure patterns of individuals/families and the decision prowess of the consumers based on family pressure, social expectation and availability of funds. Hence, the study evaluated the influence of knowledge and other decision variables of consumers in the acquisition household appliance, in the FCT.

Hence, the broad objective of the study was to determine the influence of knowledge and other decision variables in the acquisition of household appliance by civil servants and self-employed. Specifically the study determined the influence of social class income, family life cycle and education

as well as the differences between males and females on the extend of knowledge in research in the priority acquisition of household appliance.

## MATERIALS AND METHODS

The research design adopted for this study was the descriptive survey research design. The study was carried out in Abuja the administrative Centre of the Nigerian nation and a representative of people from various segment of the Federation. The Federal Secretariat houses the employee, ministries and parastatals of the Federal Government of Nigeria. The inhabitants were mostly civil servants. It is located in the central cadastral zone of Garki district. Garki is the principal business district in Abuja. The secretariat lies between latitude 9.066° north of the equator and longitude 7.4833° east of Greenwich meridian the mean maximum and minimum temperature were 33.34°C and 22.25°C respectively. The respondents were fairly educated and employed, therefore it is reasonable to assume that employment and education of the respondents exposes them to acquire financial knowledge and information and to form personality through interaction with colleagues and other people.

The federal secretariat which houses most of the ministries and parastatals of the federal government and employee as civil servants was selected for the study. The convenience sampling technique was adopted for the distribution of questionnaire.

Two hundred (200) respondents were surveyed and used for the analysis of the study.

A forty nine (49) item structured questionnaire covering three (3) sections was formulated. Section A comprise nine (9) questions that provided information about the backgroundof the respondent. Section B comprise twelve (12) which provided information about the decision-making process of the consumers.

Questions were formulated and given to three (3) professional who made contributions and vetted the instrument.

The reliability of the instrument was determined at 0.832 Chromback Alpha and ANOVA was used to determine the degree of difference in the extent of knowledge/information in the acquisition priority of household appliance to indicate sound priority acquisition on the account of consumers' social class, income, family life cycle and educational qualification of respondents at 0.05 alpha significance. A summary of descriptive statistics as well as ANOVA statistical data were reported.

## **RESULTS AND DISCUSSION**

**Table 1.** Frequency distribution of respondents showing social class, income, family lifecycle and educational qualification.

Social class	Frequency	Percentage
Male		
Lower class	10	10
Middle class	44	44
Upper class	11	11
Elite	0	0
Female		
Lower class	9	9
Middle class	23	23
Upper class	3	3
Elite	0	0
Income		
Male		
<b>№</b> 18,000- <b>№</b> 50,000	10	10
₩51,000-₩100,000	12	12
N101,000-N150,000	7	7
₩151,000-₩200,000	12	12
Above №200.000	24	24
Female		
₩18.000-₩50.000	11	11
₩51 000-₩100 000	1	1
N101.000-N150.000	4	4
₩151 000-₩200 000	11	11
Above ₩200 000	8	8
Family lifecycle	0	Ũ
Male		
Establishing stage	6	6
Expanding stage	43	43
Contracting stage	16	16
Female	10	10
Establishing stage	6	6
Estuding stage	25	25
Contracting stage	4	4
Educational qualification	7	-
Male		
Ph D	5	5
Med/MA/MSc	14	14
BA/B Sc/B Ed/HND	41	14 /1
NCE/ND	41	41
SSCE	4	4
SSCE	1	1
FSLC	0	0
Non formal education	0	0
Female	0	0
Ph. D	0	0
M.ed/MA/M.Sc	9	9
BA/B.Sc/B.Ed/HND	22	22
NCE/ND	4	4
SSCE	0	0
FSLC	0	0
Non formal education	0	0

Frequency distribution of demographic variable: and social class, monthly income level, family life cycle and educational qualification, showed that social class of the male were mostly middle class, forty-four percent (44%). Similarly most female, twenty-three percent (23%) belong to the middle class. Upper class for male, eleven percent (11%) and for male and lower class ten percent (10%), while the middle class for female lower is nine percent (9%) and upper class for female is three percent (3%).

The monthly income of the male respondents were above two hundred thousand Naira ( $\aleph$ 200,000) twenty-five (25%),  $\aleph$ 151,000-200,000 twelve percent (12%),  $\aleph$ 51,000-100,000 twelve percent (12%),  $\aleph$ 18,000-50,000 ten percent (10%) and  $\aleph$ 101,000-150,000 seven percent (7%). The female respondents were higher at  $\aleph$ 151,000 -200,000 eleven percent (11%),  $\aleph$ 18,000-50,000 eleven percent (11%), above N200,000 eight percent (8%) and  $\aleph$ 101,000-150,000 four percent (4%).

The family lifecycle of the respondents (male and female) were higher at expanding stage fortythree percent (43%) and twenty-five percent (25%) respectively. The contracting stage was sixteen percent (16%) and for the female establishing stage sixpercent (6%) for the male respondent (6%) and contracting stage four percent (4%).

The educational qualification of the male respondents were BA/B.Sc/B.Ed/HND forty-one percent (41%), M.Ed/MA/M.Sc fourteen percent (14%), Ph.D five percent (5%), N.C.E./ND four percent (4%) while for the female respondents were BA/B.Sc/B.Ed/HND twenty-two percent (22%), M.Ed/MA/M.Sc nine percent (%) and N.C.E. four percent (4%).

Hypothesis 1: There is no significant difference in the extent of knowledge/information in the acquisition priority of household appliance indicating sound priority acquisition on the account of respondents' social class.

Table 2: One way analysis of variance according tosocial class of respondent

Social Class	Ν	Mean	Std. Deviation	Sig.
Lower Class	33	114.6970	11.80171	0.00
Middle Class	133	112.1128	13.30052	
Upper Class	30	116.0667	16.30725	
Elite	4	131.0000	.81650	
Total	200	113.5100	13.68122	

The test for ANOVA descriptive statistics revealed that significant difference exists among respondents regarding the extent of knowledge on the acquisition of household appliance indicating sound acquisition priority on the account of their social class. This is because the P value of 0.025 is lower than the alpha level of significance and the mean values of 114.6970; 112.1128; 116.0667; and 131.1000 for social class of lower, middle, upper and elite respectively. Therefore, the null hypothesis is rejected.

Hypothesis 2: There is no significant difference in the extent of knowledge/information in the acquisition priority of household appliance indicating sound priority acquisition on the account of respondents' income.

Table 3: One way analysis of variance according to income of respondent

Income	Ν	Mean	Std. Deviation	Sig.
<b>№</b> 18,000- <b>№</b> 50,000	43	119.1395	10.45530	.000
₦51,000-₦100,000	24	110.0000	12.37810	
₦101,000-₦150,000	20	97.4000	11.53667	
₦151,000-₦200,000	49	108.1429	14.70969	
Above №200,000	64	115.2813	13.67128	
Total	200	111.9400	14.31401	

The test of ANOVA descriptive statistics on the extent of knowledge/information on the acquisition of household appliance by respondents an account of their income, revealed the mean level of 119.1395; 110.0000; 97.4000; 108.1429 and 115.2813 at income levels N18,000.00 - N50,000.00; - N51,000 - №100,000.00; №101,000.00; - №150,000.00; №151,000.00 – №200,000.00 and №200,000.00 and above respectively reveal that the calculated P value of 0.000 is lower than the 0.05 alpha level of significance. Hence, significant difference exists indicating sound acquisition priority an account of their income. Therefore, the null hypotheses is rejected.

Hypothesis 3: There is no significant difference in the extent of knowledge/information in the acquisition priority of household appliance indicating sound priority acquisition on the account of respondents' family life-cycle.

Table 4: One way analysis of variance according to family life cycle of respondents

Family life cycle	Ν	Mean	Std. Deviation	Sig.
Establishing stage	34	112.6471	17.12323	.801
Expanding stage	126	114.5238	14.55951	
Contrasting stage	40	114.5000	13.88968	
Total	200	114.2000	14.83511	

Details of ANOVA descriptive statistic regarding the extent of knowledge/information on the acquisition of home appliance of respondents on account of their family life-cycle revealed that significant difference does not exist. This is because the mean values of 112.6471; 114.5238; and 114.5000 for establishing stage, expanding stage and contracting stage respectively and the calculated P value of .801 is higher than the 0.05 alpha level of significance. Therefore, the null hypotheses is accepted and retained.

Hypothesis 4: There is no significant difference in the extent of knowledge/information in the acquisition priority of household appliance indicating sound priority acquisition on the account of respondents' educational qualification.

Table 5: One way analysis of variance according to educational qualification of respondents

Educational qualification	Ν	Mean	Std. Deviation	Sig.
Ph. D	6	116.6667	16.29315	.130
M.ed/MA/M.Sc	46	109.6522	15.23186	
BA/B.Sc/B.Ed/HND	128	113.4297	13.28648	
NCE/ND	16	108.5000	14.38054	
SSCE	4	100.2500	12.28481	
Total	200	112.0000	14.02367	

ANOVA descriptive statistic in respect of the extent of knowledge/information on the acquisition of household appliance indicating sound priority acquisition of the respondent showed that on account of their educational qualifications significant difference exists among the respondents. This is because the mean values of 116.667; 109.6562; 113.4297; 108.3000 and 100.2506 for educational levels Ph.D; master degree, Bachelor degree and HND degree, NCE/ND and SSCE qualification respectively. The calculated P values of 1130 is higher than the 0.05 alpha level of significance. Therefore, the Null hypothesis is retained.

Hypothesis 5: Difference between males and female in the extent of knowledge on the acquisition of household appliance indicating sound priority acquisition on account of research.

Two (2) sample t-test of knowledge indicating sound priority acquisition on the extend of research by males[sig. 0.000] and females[sig. 0.017] at t-critical value of 1.96 showed that there is no significant difference between does who make research and those who donot make research before purchase of household appliances.

Social class and income of respondents indicated that significant difference exists in the extent to which knowledge/information influence their

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acquisition of household appliance. It appears that those with higher status and income lack enough time to seek knowledge that will guarantee sound priority acquisition engagement. Consumers go for these products based on brand names instead of searching for information regarding their durability and ease of use. Ajzan (2001), pointed out that consumer information services is vital to household acquisition which involves having good knowledge/information of the commodity to ensure suitability for its intended use. It seem, however, according to Tianet al. (2001), that the quest for social factor is a motivation for purchase used to impress others. Schifman and Kanuk(2009), also noted that higher price indicates affordability and status while emotional aspect of the decision making become pertinent on the decision making process and consumption patterns.

Family life cycle and level of educational qualification revealed that there is no significant different in the extent to which knowledge influence sound priority acquisition of household appliance of the respondents. Armould, *et al.*,(2004), opined that because of the dynamic sense by which family interacts to satisfy their personal and mutual needs, the buyer behaviour is strongly influenced by members of the family. Raffe (2004), explained further that the family influence consumer behaviours by learning, listening and watching. Therefore, consumption decisions are made within the context of the family setting as a unit.

Overall, males and females donot differ among those who do research and those who donot do research about the household appliance before acquisition to indicate sound priority acquisition. This implies that generally both male and female consumers donot of necessity make research before purchase of household appliance. However, the few females who make research before acquisition seem to have higher knowledge about the household appliance than those who do not.

#### CONCLUSION

The study has shown that consumers of higher social class and income go for brand names instead of going out to search for knowledge and information about the product to ensure durability and suitability of the appliance for its intended use. This could be because they lacked time and/or they want to impress others rather than take time to seek knowledge. Also, social class and income does not have any influence on the priority acquisition on consumer in the purchase of household appliance.

Family life-cycle and educational qualification influence the extent of knowledge for sound priority acquisition because consumer decision are usually made within the context of the family setting and that consumer behaviour in the family are influenced by learning, listening and watching.

It is recommended that The Nigerian consumers who belong to high social class and income do not make time to seek knowledge from various sources to enable them make sound priority acquisition of household appliance. Therefore it is recommended that consumers of high social class and income can delegate assistants/associates to seek for adequate knowledge or information on their behalf before committing themselves to the purchase of household appliance. This would ensure they derive value and satisfaction for the money they spend.

Similarly, consumers of higher social class and income may avail themselves to internet technology within their comfort zones to access information about household appliance before purchase of the product in order to make comparative assessment before purchase of household appliance.

Since the study was limited to the Federal Secretariat Complex, Abuja most of whom are civil servants, it is recommended that the study should be replicated on a wider audience of consumers of various professional background. This will enable expert to have accurate information of the status quo in the nation.

#### REFERENCES

Armonld, E.J.I, Price, L.K. and Zinkman, G. (2004). Consumers. Burr Ridges I.L, Mc Craw Hill.

- Ajzen, L.K. (2001). Nature and Operation of Attitudes, Review of Psychology. 52. Pp 27-58
- Brown, D.I (2009). Social Status and Class in Concise Encyclopedia of Pragmatics *Elserver*. P. 952 ISBN. 918-0-08-096297-9
- Boschoff, C. Lamb (jr) C.W. Hair J.F. Michael, C. Terblande, N.E. R., Klopper, H.B. (2010). *Marketing*. Cape Town. Oxford University Press.
- Cherlin, A.J. (2002). Public and Private Families: An Introductin. New York. Mc Craw-Hill.
- DeGenova, K.M. Rice, F.P. (2001). Intimate Relationship, Married and Families. (5th ed).U.S.A. Mayfield Pub. Co.
- Duplesiss, P.J. and Rousseus, G.G. (1999). *Buyer Behaviour: A Multicultural Approach*. Jourhanessburge. Verhund Thompson Blue.
- English-Leuck, J.A. (1998). Technology and Social Change: The Effects on Family and Communities. *COSSA Congressional Seminar*, San Jose State University
- Gerald, E.S. (2012), Economic Value, Frames of Reference, and the Impact of Framed Positioning Strategies in Businessto-Business Markets, in Mark S. Glynn, Arch G. Woodside (ed.) *Business-to-Business Marketing Management: Strategies, Cases, and Solutions* (Advances in Business Marketing and Purchasing, Volume 18) Emerald Group Publishing Limited, pp.283 - 322
- Hopkins (2006) Learning Environment, Needs, Wants and Attitudes on Products.
- Ogboyomi, V. (1999). Selection of Some Household Equipment Among Educated Working women in Kaduna Metropolis, Unpublish project ABU, Zaria.
- Raffe, A. (2004). The key to Targetting lives in users behavior. New media and Age.
- Schiffman, L., and Kanuk, L. (2009). Consumer Behaviour. Printice hall.
- Tian, K. T., Bearden, W.O. Hunter, G.L. (2001). Consumer needs for Uniqueness. *Journal of Consumer Research*. 28:84-96
- Frust, P. (2006). Television: How does it Influence Your life? *Awake magazine* Vol.6 ISBN 4 MCB UP Ltd. Pp. 234-248.
- Peng, H. Nicholas, H. and Sabyosichi, M. (2009). Searching to experience on the web. An Empirical Examination of Consumer Behaviour for Search and Experience Foods? George. Pp. 58. 59.





# PHYSICAL SCIENCES

#### DESIGN AND IMPLEMENTATION OF A COMPUTERIZED LIBRARY SYSTEM FOR THE NATIONAL INSTITUTE OF POLICY AND STRATEGIC STUDIES, KURU NIGERIA.

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#### ABSTRACT

Most educational institutions in Nigeria, such as the Universities, Polytechnics and Colleges of Education still operate on the manual method of library functions of acquisition, cataloging and circulation. This paper examines the inadequacies involved in the manual method of acquisition, cataloging and circulation functions of a library and proposes a solution by developing a software application to facilitate the automated processing of these library functions. The software was developed using Visual Basic 6.0 and employing MS-ACCESS Relational Database Management System in designing the database. The developed software was tested and found to perform well and produced expected results on completion. With this program, it was possible to record books that were acquired by the National Institute for Policy and Strategic Studies, (NIPSS) as well as the cataloging and the circulation section of the library. The new system has some qualities such as reduction in the cost of processing of information, reduction in time spent in the acquisition, cataloging and circulation of books, increase in accuracy and efficiency, and elimination of duplication of effort which makes it superior to the manual system of information processing. This new system is flexible and can be modified to suit any kind of library and data processing need.

Keywords: Library functions, Automated Library, Computerized Library, Acquisition, Cataloging, Circulation

## INTRODUCTION

The idea of easy, finger-tip access to information is what we conceptualize as digital libraries today began with Vannenar Bush's Memex machine (Bush, 1945) and has continued to evolve with each advancement in information technology. With the arrival of computers, the concept centered on large bibliographic databases. the now familiar online retrieval and public access systems that are part of any contemporary library. Phrases like "virtual library," "electronic library," "library without walls" and, most recently, "digital library," all have been used interchangeably to describe this broad concept. The problem is that due to the fast growing sector of library; the ancient methods of maintaining it are no longer effective and efficient for retrieval and dissemination of information and better services for the users. Applications of cutting edge-technology have become paramount. A perfect/ correctly computerized library will help its users with quick and prompt services. It is often stated that libraries are born when people began to organize information and provide access to that information.

Library automation/computerization refers to mechanization of library operations predominantly by computerization Kochar and Sudarshan (2008). The most commonly known operations of a library are acquisition control, serials control, cataloguing and classification and circulation control. The implementation of the program written by the researcher and the deployment of the e-Granary that the ICT Department just acquired for the Library will fully automate the library operations of the National Institute. e-Granary is a collection of numerous and diverse databases of information on different fields, while the Visual Basic program integrated with Microsoft Access will enable the automation of a database for the existing books in the library.

Organizations all over the world have problems which vary depending on management and financial buoyancy. In the case of the National Institute for Policy and Strategic Studies (NIPSS), Kuru, the library is faced with series of issues from lack of funding which has been going on for a number of years and has led to inadequate collection of books, journals, and working tools. Materials in the library are obsolete and outdated; all library activities are still being done manually, the only electronic service being rendered is the searching of materials on the internet; the internet facility was donated to the institute by Nigeria Communications Commission (NCC) and is being managed by the ICT department. The Packages used for designing the Library Software is Visual Basic 6.0 and is employing MSACCESS Relational Database Management System in designing the database.

## MATERIALS AND METHODS

Generally System development is all about the transition from one mode of data processing to another or modification of an old existing one. The design of a computerized library software partly evolved from the need for a user friendlier package that will facilitate the functions of a library. Changes of system are necessitated by a number of factors ranging from growth of business to change in national law. For instance, there could be, changes in business policies and regulations, change in government policies and regulations and new innovations/development of better methods of system operations. For any of these reasons or more, a system can be forced to change. The library software is designed to overcome the

The library software is designed to overcome the limitations as exist in the system. To achieve this, the software has to be structured to include the following:

- a. A relational database support and dependency this feature promotes the efficient use and storage of data. It equally optimizes data organization by the use of tables in the database.
- b. Efficient System Resource Usage: database are normally saved as compressed database before and after their use by the system, thus reducing the disk storage space they might take.
- c. Customizable data structure: The Library software can be readily adopted to serve within different corporate setting.
- d. Ergonomically Designed User Input Forms: The software input forms are such that information inputs or displays are handled by same form formats. Besides, the modules are such that they facilitate easy user input or modifications to the database at points where they are needed to be updated.
- e. Backup feature: The user has the options of backing data in the database to removable drivers, disk or to the system. This is a strong maintenance culture that can facilitate data recovery and smooth system running in times of system crash or any other system errors.

The National Institute for Policy and Strategic Studies, Kuru, Jos is an organization with a population of four hundred and twenty six (426) staff. The organization is set up to carry the functions of Strategic/Policy Formulation for the Country. The organization as its functions dictates has its main office in Kuru, Plateau State and a liaison office in Abuja.

In this study, information was acquired through two sources namely: Primary source and Secondary source. The reason for this is to gather information and necessary data about the existing system so as to adopt a way of designing the new system. Information from the primary source was given priority because itis first-hand information.Primary data are those got form questionnaires, personal interviews, observations, etc. (Chukwuemeka and Oji 1999; 56). Secondary Source information is second hand information and according to Chukwuemeka and Oji (1999; 56), "Secondary data are those gathered from pamphlets, journals, newspapers, books and records available at the organization under study".

An interview involving a face to face discussion with library staff was conducted. Questions were asked and responses received and this determined how library functions are carried out based on the responses to the questions asked by the researcher. It was obvious that the library Department of the National Institute was manually operated and records manually handled in files (paper work).

The researcher also had the advantage of being a staff of The National Institute and it was relevant to observe critically and participate where necessary in the activities of the library Department to arrive or draw some conclusions.

The System inputs are manually provided through various input forms. Therefore a computer operator trained on this package is needed. The content of these forms are save to files on the local system. Each forms format differs depending on the section of the package being accessed.

The system output from the system is provided on demand from the printout whenever it is needed and will necessitate the running of the program. The interface (form) desired are then generated and printed out.

Files and Records at NIPSS library are maintained by thetraditional computer filing system using Microsoft excel and Word programs. This implies that several data have to be manipulated based on fixed system metadata i.e. structure which defines how data is to be accepted and stored in the file. Upon these structures, the accepted data are then organized in the files as records.

In the course of the development of the library software, visual Basic (VB) is the choice programming language. The Visual Basic has powerful features that are extended by Microsoft within the enterprise edition that makes Visual Basic the choice language for this project or work. Some of these features includes:

- 1. The rich set of development and system tools such as the code profile that are shipped with visual Basic (VB)
- 2. The Rapid Application Development (RAD) environment offered by visual Basic and targeted at 32 bit windows development.
- 3. The ease with which Graphical user interface is developed in Visual Basic (VB).
- 4. It interface easily well with relational data base system like Microsoft Access and it supports

structural query languages like oracle (SQL)

- 5. Visual Basic has very efficient and easy to use debugging tools.
- 6. It comes with a customizable set up and software packaging tools for easy product distribution and installation.

## **RESULTS AND DISCUSSION**

The developed software application was run on the system and found to operate as expected. The login screen is as shown below. Once the user is able to log in, the main window appears. If the password entered is valid, the software will then open the main page. The main page/window has five tabs; the Acquisition, Catlog list, Circulation and the exit tab. The Acquisition automates the book ordering process, keeps track of items on order and allows for tight control of budgets. Acquisitions is usually linked to the cataloguing module providing an easy means of checking for items before ordering to ensure against duplication , and enabling library users to see (and Often reserve) items on order.

The Cataloguing is usually the core module of an automated library system, without which no other modules will function. It allows bibliographic records to be created into the system and parameters relating to them to be set. The catalogue can usually be searched via a menu or a command driven system. Systems are usually flexible enough to give a choice in how the information is displayed in a record. Such records can also be edited and deleted.

The circulation module is used for issuing, returning books or other items of stock, renewals, reservations, overdue and the calculation of fines. It also enables the production of notices to library members. Lending periods and types of membership can be defined.

## **CONCLUSION AND RECOMMENDATIONS**

In order to introduce the use of computers into the manual operation of the library, careful investigation and analyses were carried out on the existing method. This work has presented a software application meant to ease the operation of the library in The National Institute for Policy and Strategic Studies (NIPSS), Kuru. The application was successfully developed, tested, and found to be working as expected. The Application software is flexible and can be modified to suite any kind of library and data processing. It is easy to use due to the use of a GUI (Graphical user interface) rather than command-line approach, reasonably secure, and enforces data integrity resulting from the use of a relational database management system. With this application, library functions can be automated to a large extent, thereby reducing processing time and increasing accuracy. FULafia Journal of Science & Technology Vol. 2 No.1 March, 2016

The efficiency of the software can be further enhanced based on the following recommendations: Effort should be made to validate the input data to ensure the integrity of the system. The primary users should be given an initial orientation on how to interact with the system for optimal utilization of the facilities of the system. ACKNOWLEDGEMENT A great appreciation goes to my wife (Temitope Olayode) and children, my supervisors for their critical corrections on work. The effort of Alh. Bawa Ahmed is also acknowledged in conceptualizing the design of this system and making the implementation and testing of this system possible and practicable.

#### REFFERENCES

- Abdulraheem, S., &Muta, T. (2005). "Evaluation of automated services in Nigerian Universities". *Electronic Library*, 23(3), 274 288.
- Abrambam, H., Devi,H. &Purnima, D. (2005). Application of Information Technology in\Special Libraries of Manipur: A Case Study.

Bush, V. (1945). "As We May Think", Atlantic Monthly. Pp. 101-108.

- Chukwuemeka, E. E.O. & Oji, O. R. (2005). "Applied Social and Behavioral Research, Guideline for thesis writing". Enugu, John Jacob"s Classic. A Foundation for Transformation, E-Learning Report.
- Gladney, H.M. (1994). Digital Library: Gross structure and requirements: Report from a workshop. IBM Research Report.
- Khan, R. E., & Cerf, V.G. (1988). The Digital Library Project Volume I: The World of Knowbots, (DRAFT): An Open Architecture For a Digital Library System and a Plan For Its Development.

Reston, V. A: Corporation for National Research Initiatives.

Kuny, T. &Cleveland, G. (1998). The Digital Library: Myths and Challenges. *IFLA Journal*,24(2),107-113. Olaniyi, S. (2006). E-learning Technology: The Nigeria Experience, Munich Germany, October 8-13, 2006 Sukhdev, S. (2003). *Digital Library*: Definition to Implementation. M Pub.



Figure 1: The program's flow chart



Figure 2: Log in Page (Validates user account before access is granted)



Figure 4: Catlog List



Figure 3: TheMain Page/window showing the main Figure 5: Acquisition Control menu and the side menu

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Figure 6: Circulation Control





# PHYSICAL SCIENCES

## DIRECT NUMERICAL METHOD FOR GENERALIZED OPTIMAL CONTROL PROBLEMS CONSTRAINED WITH ORDINARY DIFFERENTIAL EQUATIONS.

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#### ABSTRACT

In this paper, we considered general class of continuous optimal control problem governed by Nth-order ordinary differential equations, in which the state and control variables are and column vectors respectively with corresponding matrix coefficients of dimension  $n \times n$ ,  $n \times r$ . We adopt direct numerical method where the continuous optimal control problem is converted to a nonlinear programming problem via Augmented Langrangian which makes it amenable to optimization techniques (Conjugate Gradient Method). The result is compared with an existing method (exterior penalty method) and found to be more accurate.

Keywords: Trapezoidal rule, Cranck-Nicholson, Augmented Lagrangian, Conjugate Gradient Method.

#### **INTRODUCTION**

Optimal control problems are most often solved numerically because of the complexity of most applications; these numerical methods are dated back to the 1950's with the work of Bellman, (1966), Bellman and Dreyfus, (1959), Bellman *et al.*, (1963).

Optimal control problems governed by ordinary differential equations arise in a wide range of applications. Of special interest is the Linear Quadratic Optimal Control problem (LQOCP), which had been greatly studied Bertsekas, (1974), Ibiejugba and Onumanyi, (1984), Olotu and Olorunsola, (2006) due to its interesting features and its widerapplicability. Sargent, (2000) gave historical survey of optimal control and went on to review the different approaches to the numerical solutions of optimal control problems. The function space algorithm for solving both continuous and discrete linear quadratic optimal control problems was given by Polak, (1971).

Most of the algorithms for solving unconstrained optimal control problems are based on a class of descent methods which traditionally have been the principal methods for solving unconstrained minimization problems. Efficient, within this class, are steepest descent (SD), Fletcher and Powell (1964), Klessig (1972) which had been classified as algorithms with no memory, and the Newton and quasi-Newton methods which update the hessian inverse of f(x).

In most applications, the conjugate gradient algorithm is more suitable when compared to other conjugate direction algorithms Hestenes and Stiefel, (1952). It totally outshinesthe steepest descent method, and compares more favourably with the Newton and quasi-Newton methods. For example, the Newton descent and Quasi-Newton descent method are not suitable for minimising the Rayleigh quotient associated with a matrix, since any attempt to approximate thehessian at the minimum is a singular matrix, Yang, (1989). Also when the dimension of the optimization variable is very large, most especially in optimal control, the conjugate gradient method is preferred.

Most research works in the field of unconstrained optimization concentrate their efforts on algorithms with inaccurate or no line search. This is due to the fact that the line search part is timeconsuming. However, the reviewed literature was mainly analytical in approach and did not consider any direct method amenable to direct numerical algorithms, except for the recent publication by Olotu and Adekunle (2012), on the algorithm for a numerical solution to an optimal control problem governed by delay differential equation purely on the state variable with emphasis on vector-matrix

coefficients.

This research seeks to address thedirect numerical approach using augmented lagrangian to solve this optimal control problem governed by ordinary differential equations with matrix coefficients using augmented lagrangian to formulate the penalized matrix thereby rendering the nonlinear programming problem amenable to Conjugate Gradient method.

#### **PROBLEM FORMATION**

Consider the optimal control problem,

subject to  $X(t) = Ax(t) + Bu(t), X(0) = X_0, 0 \le t \le Z$ . .....(2.2)

Unlike the indirect numerical method where the optimality condition is performed on the optimal control problem thereby resulting in boundary value problem, Olotu and Olorunsola (2006). The main idea in this work centers on the conversion of the continuous-time optimal control problem into a discretized Nonlinear Programming Problem(NLP) problem via the augmented multiplier method which makes it amenable to Optimization Techniques (Conjugate Gradient Method) so as to compute the near optimal control trajectories. This numerical result is then compared with that obtained from the use of exterior penalty method to form our Nonlinear programming Problem.

#### **MATERIALS AND METHODS**

Consider the optimal control problem,

$$\min I(x,u) = \int_{0}^{Z} (x^{T}(t)Px(t) + u^{T}(t)Qu(t))dt \qquad \dots \dots \dots \dots (3.1)$$

subject to:  $X(t) = Ax(t) + Bu(t), X(0) = X_0, 0 \le t \le Z_1$  .....(3.2)

where  $x(t) \in \mathbb{R}^n$ ,  $u(t) \in \mathbb{R}^r$ ,  $P_{n \times n}$ ,  $Q_{n \times n}$  are symmetric positive definite and  $A_{n \times n}$ ,  $B_{n \times m}$  are not necessarily positive definite matrices.

We make equation (3.1) and (3.2) solvable by conjugate gradient method by replacing the constrained optimal control problem by appropriate approximate discretized control problem. We break the interval into equal sub-intervals with knots  $t_0 < t_1 < t_2 < \dots < t_w$  and say  $\Delta t_i = 0.1$ 

Define 
$$h = Z - 0/W$$
 .....(3.3)  
Discretization of the performance index

We seek to discretize our cost functional using trapezoidal rule. We break the interval into equal subintervals such that

$$\int_{0}^{z} (x^{T}(t)Px(t)+u^{T}(t)Qu(t))dt = \frac{h}{2} \sum_{k=0}^{w} f(x_{k}) + f(x_{k-1}) + f(u_{k}) + f(u_{k-1}) \dots (3.1.1).$$

$$\min I = \frac{h_2}{2} \sum_{k=0}^{w} x_k^T Q(t_k) x_k + x_{k-1}^T Q(t_{k-1}) x_{k-1} + x_k^T R(t_k) x_k + x_{k-1}^T R(t_{k-1}) x_{k-1} \qquad (3.1.2)$$
  
$$\min I = \sum_{k=0}^{w} x_k^T \overline{Q}(t_k) x_k + x_{k-1}^T \overline{Q}(t_{k-1}) x_{k-1} + x_k^T \overline{R}(t_k) x_k + x_{k-1}^T \overline{R}(t_{k-1}) x_{k-1}, \qquad (3.1.3)$$
  
where  $\overline{Q} = Q \frac{h_2}{2}$  and  $\overline{R} = R \frac{h_2}{2}$ 

Similarly, we shall discretize our state equation using Crank-Nicholson Method  $x_{k+1} - x_k = \frac{h}{2} \{ f(x_{k+1}, u_{k+1}) + f(x_k, u_k) \}$ (3.1.4)

$$x_{k+1} - x_k = \frac{h}{2} \left\{ A x_{k+1} + B u_{k+1} + A x_k + B u_k \right\}$$

$$(1 - A\frac{h}{2})x_{k+1} = (A\frac{h}{2} + 1)x_k + B\frac{h}{2}(u_{k+1} + u_k)$$
$$x_{k+1} = \overline{A}x_k + \overline{B}u_{k+1} + \overline{B}u_k, \qquad (3.1.5)$$

where  $\overline{A} = (Ah+2)*inv(2-Ah)$  and  $\overline{B} = inv(2-Ah)*Bh$ 

Hence the discretised optimal control problem becomes,

$$\min I = \sum_{k=0}^{\infty} X_{k}^{T} \overline{Q}(t_{k}) X_{k} + X_{k-1}^{T} \overline{Q}(t_{k-1}) x_{k-1} + x_{k}^{T} \overline{R}(t_{k}) x_{k} + x_{k-1}^{T} \overline{R}(t_{k-1}) x_{k-1}$$
(3.4)  
subject to  $X_{k+1} = \overline{A} X_{k} + \overline{B} U_{k+1} + \overline{B} U_{k}$ .....(3.5)

By parameter optimization, Betts (2001), the discretised problem becomes a large sparsequadratic programming problem, written in matrix form as:  $I(v) = v^{T}Tv + n$ (3.6)

subject to

Hv = k (3.7) where T is a block diagonal matrix of order (n+r)(w+r) with entries given by

$$T_{ii} = \begin{cases} 2\overline{Q}(t_i) & i = 1, 2, 3, ..., w - 1 \\ \overline{Q}(t_i) & i = w \\ \overline{R}(t_i) & i = w + 1 \\ 2\overline{R}(t_i) & i = w + 2, w + 3, ..., 2w \\ \overline{R}(t_i) & i = 2w + 1 \\ \end{cases}$$
(3.8)

where the  $i^{th}$  element corresponds to  $i^{th}$  block and  $_{d=x_0\bar{Q}x_0}$  such that matrix H is a block matrix of dimension  $_{nw\times(n+r)w+r}$ . This can be written in matrix representation as

where *E* is an  $nw \times nw$  block matrix bidiagonal with principal block diagonal elements  $[E]_{ii} = I_{n\times n} - \frac{h}{2}A(t_i)$ and lower principal diagonal  $[E]_{ij} = -I_{n\times n} - \frac{h}{2}A(t_{i-1})$ , for every *i*, *j* block such that i = j+1. The matrix *F* is an  $nw \times (w+1)r$  block bidiagonal matrix with principal  $[F]_{ii} = -\frac{h}{2}B(t_{i-1})$  and upper block principal diagonal elements  $[F]_{ij} = -\frac{h}{2}B(t_i)$  for every *i*, *j* such that j = i+1. The column vector is of order with entries given by  $[k]_{i} = -\frac{h}{2}A(t_i)X_{i}$  and  $[k, k] = -\frac{h}{2}A(t_{i-1})$ . by  $[k]_{1:n,1} = (I_{n\times n} + \frac{h}{2}A(t_0)X_0)$  and  $[k_{i,1}] = 0$ , i = n+1, n+2, ...nw.

The unconstrained minimization problem by Augmented Lagrangian function is  $\min L_{\rho} = v^{T}Tv + d + \lambda^{T} |Hv - k| + \frac{1}{\mu} ||Hv - k||^{2}$  (3.11) On expansion, we have

 $\min \hat{L}_{\rho}(v) = v^{T} T_{\rho} v + B^{T} v + C \quad (3.12)$ 

Equation (3.12) is the quadratic form representation for the unconstrained minimization problem, where  $L_{\rho}(v)$  is the penalized lagrangian,  $\rho$  is the penalty parameter, the penalized matrix

$$T_{\rho} = \left[ V + \frac{1}{\mu} H^{T} H \right], \quad B^{T} = \left( \lambda^{T} H - \frac{2}{\mu} k^{T} H \right) \quad \text{and} \quad C = \left( d - \lambda^{T} k + \frac{1}{\mu} k^{T} k \right) \quad \cdot$$

The Operator  $T_{\rho} = \left[ V + \frac{1}{\mu} H^{T} H \right]$  is positive definite, see proof in Olotu and Akeremale, (2012)

#### NUMERICAL ALGORITHM

- (1) ChooseZ<sub>0.0</sub>  $\in \underline{R}^{(n+r)w+r}$ , C>0,  $\mu$ >0,  $\lambda$ >0, d0. set j=0
- (2) Set i=0 and  $p_0 = -g_0 = -\nabla L_p(Z_{0,0})$
- (3) Compute  $\alpha_i = (\underline{g}_i^T \underline{g}_i) / (\underline{p}_i^T A \underline{p}_i)$
- (4) Set  $Z_{(j,i+1)} = Z_{(j,i)} + \alpha_i p_i$
- (5) Compute  $\nabla L_p(Z_{i,i+l})$
- (6) If  $\nabla L_p(z_{(i,i+1)}) = 0$  and  $JZ_{(i,i+1)} = K$ , Stop. Else go to (7)

(7) If 
$$\nabla Lp(z_{j,i+1}) \neq 0$$
, set  $g_{i+1} = \nabla L_p(Z_{j,i+1})$ 

$$p_{i+1} = -g_{i+1} + \gamma_i p_i$$
  
$$\gamma_i = (g_i^T g_{i+1} g_{i+1})$$
  
$$g_i^T g_i^T$$

- (8) Set i=i+1 and go to (3)
- (9) Else, if  $JZ_{j,i+1} \neq K$  or  $JZ_{j,i+1} K = 0$ , then

set  $\mu_{k+1} = d \mu_k$ 

$$\lambda_{j+1} = \lambda_j + \mu_j (JZ_j - K)$$

(10) Set *j*=*j*+1 and go to step (2)

#### **EXAMPLES AND PRESENTATION OF RESULTS**

Example (1): consider the constrained optimal control problem

where 
$$x(0) = 1_{2 \times 1}$$
, It is clear that  $P = \begin{pmatrix} 2 & \frac{1}{2} \\ \frac{1}{2} & 1 \end{pmatrix}$ ,  $Q = \begin{pmatrix} 1 & \frac{1}{4} \\ \frac{1}{4} & 1 \end{pmatrix}$ ,  $A = \begin{pmatrix} 2 & -1 \\ 1 & -1 \end{pmatrix}$ , and  $B = \begin{pmatrix} 1 & 1 \\ -1 & 0 \end{pmatrix}$ 

By [19], the analytic objective value is I = 2.6460 and the objective value obtained using exterior penalty amenable to conjugate gradient method is I = 2.6691 why the objective value obtained using Augmented Lagrangian amenable to conjugate gradient method is I = 2.6267 as we will see in the Table 1.

Iterations	Constraints Satisfaction		Objective Value		
	DCAQP (2011)	New Scheme	DCAQP (2011)	New Scheme	
1	0.8693E-1	0.4618	0.9158	-3.0329	
2	0.1997E-1	0.9299E-1	2.0565	1.4277	
3	0.2522E-2	0.8044E-2	2.5846	2.5591	
4	0.2597E-3	0.4359E-3	2.6603	2.6248	
5	0.2604E-4	0.2198E-4	2.6682	2.6266	
6	0.2605E-5	0.1100E-5	2.6690	2.6267	
7	0.2605E-6	0.1100E-5	2.6691	2.6267	

**Table 1.**Comparison of results using existing scheme and the developed scheme.

Example (2): consider the constrained optimal control problem

min 
$$I(x,u) = \int_{0}^{1} (x_1^2 + x_1x_2 + x_2^2 + 2u_1^2 + 2u_1u_2 + u_2^2)dt$$
 .....(5.3)  
subject to:  

$$\begin{aligned} x_1 &= x_1 - x_2 + 2u_1 + u_2 \\ x_2 &= x_1 + x_2 - u_2, \end{aligned}$$
where  $x(0) = 1$   $P = \begin{pmatrix} 1 & 0.5 \\ 0 &= \begin{pmatrix} 2 & 1 \\ 0 &= 1 \end{pmatrix}$   $Q = \begin{pmatrix} 2 & 1 \\ 0 &= 1 \end{pmatrix}$  and  $P = \begin{pmatrix} 2 & 1 \\ 0 &= 1 \end{pmatrix}$ 

where  $x(0) = 1_{2 \times 1} P = \begin{pmatrix} 0 & 0 \\ 0.5 & 1 \end{pmatrix}, Q = \begin{pmatrix} 1 & 1 \\ 1 & 1 \end{pmatrix}, A = \begin{pmatrix} 1 & 1 \\ 1 & 1 \end{pmatrix}, and B = \begin{pmatrix} 0 & -1 \end{pmatrix}$ 

By Olotu and Adekunle (2012), the analytic objective value is 2.5466 and objective value obtained by using exterior penalty amenable to conjugate gradient method is I = 2.5656 why the objective value obtained by using augmented lagrangian amenable to conjugate gradient method is I = 2.5287 as inTable 2 below.

Iterations	Constraints Satisfact	ion	<b>Objective Value</b>	
	DCAQP (2011)	New Scheme	DCAQP (2011)	New Scheme
1	0.8625E-1	0.4244	0.9008	-2.8797
2	0.2002E-1	0.9435E-1	2.0497	1.3483
3	0.2448E-2	0.7573E-2	2.4995	2.4694
4	0.2507E-3	0.4030E-3	2.5588	2.5271
5	0.2513E-4	0.2028E-4	2.5650	2.5287
6	0.2514E-5	0.1015E-5	2.5656	2.5287
7	0.2514E-6	0.1015E-5	2.5656	2.5287

 Table 2. Comparison of results using existing scheme and the developed scheme.

By Olotu and Adekunle, (2012), the analytic objective value is 2.5466 and the objective value obtained by using exterior penalty amenable to conjugate gradient method is I = 2.5656 while the objective value obtained by using augmented lagrangian amenable to conjugate gradient method is I = 2.5287 as seen in the table above.

#### **CONCLUSION**

We have shown that generalized discrete optimal control problems with matrix coefficients can be solved directly via conjugate gradient method using exterior penalty method and Augmented Lagrangian method to construct the control operator (penalized matrix). However, it is observed that the new algorithm gives a better result in terms of accuracy, hence a better scheme. It is therefore recommended for generalized optimal control problems with delay-differential equations.

### REFERENCES

- Bellman, R. and Dreyfus, S. (1959), "Functional Approximations and Dynamic Programming, "Mathematical Tables and Other Aids to Computation, 13:247-251.
- Bellman, R. (1962), "Dynamic Programming Treatment of the Travelling Salesman Problem." *Journal of Association of Computing Machinery*, 9:61-63
- Bellman, R., Kalaba, R. and Kotkin, B.(1963), "Polynomial Approximation A new Computational Techniques in Dynamics Programming: Allocation Processes," *Mathematics of Computation*, 17:155-161
- Bellman, R. (1966), "Dynamic Programming," Science 1, 53: 34-37.
- Bertesekas, D. P., (1974) Partial Conjugate Methods for a Class of Optimal Control Problems. IEEE Transactions on Automatic Control, 19,: 3.
- Betts, J.T. (2001), Practical Methods for Optimal Control Problem Using Nonlinear Programming. SIAM, Philadephia.
- Fletcher, R. and Powell, M.J.D. (1964) Function Minimization by Conjugate Gradients. Comp. J., 7:149-154
- Hestenes, M. R. and Stiefel E.(1952) Methods of Conjugate Gradients for Solving Linear Systems. Institute of Research of the National Bureau of Standards, 49:409436.
- Ibiejugba, M. A. and Onumanyi P., (1984). A Control Operator and Some of its Applications. *Journal of Mathematical Analysis and Application*,103:31-47.
- Klessig R. and E. Polak., (1972) Efficient Implementation of the Polak-Rebie`re Conjugate Gradient Algorithm. SIAM *Journal Control*, 10: 524-549.
- Olotu, O. and Olorunsola, S. A., (2006). An Algorithm for a Discretized Constrained, Continuous Quadratic Control Problem. *Journal of Applied Sciences*, 9(1):6249-6260.
- Olotu, O. and Adekunle, A.I. (2012), An Algorithm for optimal control of Delay Differential Equation. *The Pacific Journal of Science and Technology*, 13: 228-237
- Olotu, O and Akeremale, O.C. (2012). Augmented lagrangian method for discretized optimal control problems, *Journal of the Nigerian Association of mathematical physics*, 2 :185-192
- Polak, E. (1971)Computational Methods in Optimization: A Unified Approach. AcademicPress Inc, London.
- Sargent, R. W. H., (2000) Optimal Control. Journal of Computational and Applied Mathematics, 124:361-371.
- Yang, X. (1989), Conjugate Gradient Algorithms for the Solution of Extreme Eigen-problem of Hermitian Matrix and its Applications in Signal Processing, Ph.D Dissertation, Syracuse University.





# PHYSICAL SCIENCES

## EMPIRICAL VALIDATION OF ONLINE FEATURES IN USER ACCEPTANCE OF WEB SHOPPING CENTERS IN NIGERIA: A PRELIMINARY STUDY

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#### ABSTRACT

Internet shopping started in the developed world around the 1990s, but in a developing country like Nigeria, it only started around the year 2012. This paper reports on the initial investigation into online features of Web shopping centers (WSCs) and their relationships with the acceptance behaviors of customers in Nigeria. We revised and adopted the model proposed by previous researchers. We were also specifically interested in exploring only the relationships between the online features and technology acceptance model (TAM) constructs in this initial study from the view of information systems research. The results of a sample survey of 51 customers show that TAM is valid for use in predicting the acceptance behaviors of customers. This in one part agrees with the results obtained in earlier studies. However, these preliminary results can serve as a basis for further investigation of customer behaviours towards Web shopping centers.

Keywords: Web shopping centers, Online features, Technology acceptance model

#### **INTRODUCTION**

E-commerce, short for electronic commerce is a concept which only recently managed to find its way to developing countries including Nigeria, Ghana, and Kenya. Just like e-banking, online shops represent a type of e-commerce. Unlike in the developed countries where Web-based shopping has rapidly grown from the middle of the 1990s, owing to advances in Internet technologies, Web shopping only started in Nigeria around the year 2010. In (Chen et al., 2002 & Keeney 1999), the benefits of Webbased shopping were highlighted to include; ease of shopping and having a vast array of products to select from, competitive pricing, easy access to information, quality of product and delivery period of products purchased. Given the rapidly increasing population of Nigeria which now stands at around 170 million people, and coupled with the aforementioned benefits, Web-based shopping in Nigeria is expected to grow very rapidly. However, with traditional shopping centers, customer requirements are easily understood and their satisfaction readily met. This is not the case with Web shopping centers (WSCs) where fulfilling customer requirements and satisfaction have grown to become a great challenge Ahn et al., (2004).

A survey of existing literature in e-commerce reveals that researchers and vendors in this field have to some extent investigated the main factors that are related to user satisfaction and their use of Web shopping centers (WSCs). To this end, the customer's perception of the quality of e-commerce delivery became a subject for examination by various researches, and thus giving rise to different views. However, this paper notes that there is no unified view whatsoever regarding the exact factors that affect user satisfaction and usage of WSCs or the examination of the user's perception of the quality of WSCs. In order to support our observation, (Torkzadeh & Dhillon 2002, Aladwani & Palvia 2002, Koufaris et al., 2002) among others in their various studies mainly investigated the factors responsible for WSC success. In the same vein, (Lin & LU 2000) descriptively and generally discussed Internet quality without considering its various aspects. These different views abound due to what birthed WSCs. There is however, the information system (IS) view. According to Lederer 2000, and Lin & Lu 2000, views that are based on IS relies on the quality of service, quality of information and quality of system to measure and predict user's acceptance behavior. There are also the marketing views which we do not focus on in this study. Also, in (Pitt et al., 1995), views that emanate from marketing rely on the perception of product, service delivery and price of product. These are known to be traditional marketing factors and the marketing views consider WSCs to be dealing with the consumer satisfaction and the intention to purchase.

In Gefen et al., 2003, Web shopping centers are considered as separate business entities that economically engages the user or customer. They should be seen beyond the user-interfaces they present for users to interact with. Just like the traditional shops on the high-streets, customers can use their Internet-enabled laptops, phones or PCs to launch their Web browser, and navigate to the WSC of their choice, search for any product of their choice and place their orders and then wait for delivery products within an estimated period. Unlike offline customers who shop on the high-streets, online customers who patronize WSCs have their unique requirements and issues that are occasioned by the Internet platform. Other characteristics are common to both types of customers. Ahn et al. (2004), suggested that online and offline quality of WSCs are likely to significantly affect the attitude and perception of customer patronage of WSCs.

In this study, we first carried out an empirical investigation of the online features of shopping websites from the point of view of IS. Secondly, we explore the relationships between the online features and behavioral acceptance of customers via path coefficient analysis using TAM as the theoretical basis for the exploration. We focus on how each online quality factor relates with TAM's individual constructs.

Our major contribution in this study is that we specifically carried out an empirical measurement of online quality features as they affect user's behavioral acceptance of Web shopping centers. Based on our sample data, we showed to an acceptable degree that online quality factors significantly impacts customer acceptance of Internet shopping sites.

In the next section, we introduce literature related to this work. Subsequent sections present the conceptual model development, outcome of the survey and discussions. The last section focuses on the implications of the work, limitations and direction for future work.

The advancement in Web technologies caused Nigeria to witness an upsurge in the number of Web shopping centers. The phenomenon of Online shopping which was rare in developing countries has suddenly changed, promoting online buying behavior for various products and services. Aminu (2013) examined the challenges that militate against adoption of online shopping in the Nigerian retail industry, while Olajubu (2009) identified various issues affecting the development and implementation of e-Shopping for developing nations' businesses, proposed solutions to these shortcomings and presented an e-Shopping model for developing nations' small and medium enterprises.

Evaluating the acceptance and adoption of business-to-consumer (B2C) e-commerce in Nigeria using the extended technology acceptance model (TAM) with task-technology fit, Ayo (2011) opined that the use of the Internet for B2C e-commerce depends on usefulness, task fit, and trust suggesting that a Web retailer must put up websites that are rich enough for consumers to be certain of making the right choices. Osotimehin *et al.*, (2015) suggested that factors such as quality of products, security and trust in Web retailers have the strongest predictive power of adoption of Web shopping centers while website design and level of income are the least factors influencing customer's adoption of online shopping sites.

The current state of research in Nigerian electronic commerce appears to indicate that majority of the research focused on factors militating against acceptance and adoption of Web shopping centers. There is no research to suggest that online shopping centers have been considered as a Webbased system in the context of information systems (IS), and no research has been targeted at revealing the impact online and offline features have on the user acceptance of online shopping sites in Nigeria. This is therefore the focus of our study and next discussion further highlights our views.

### MATERIALS AND METHOD

Web shopping centers involves activities that are both information system and marketing oriented. In this section and within the focus of our study, we consider literature about online features of Internet shopping centers. The online features of shopping websites evolved from information system and Web quality metrics. They are used to refer to the quality of Web shopping centers. These measures include information, service and system qualities of the shopping websites. Ahn *et al.*, (2004) introduced the offline features of online shopping malls based on marketing views. Offline features include measures like the quality of product and service delivery. They specifically used TAM as the theoretical foundation for exploring user acceptance of shopping websites.

The Internet is a key driver of electronic commerce. According to Ahn *et al.*, (2004), "online features are the quality measures of a Web system or services provided by the Web system". Internet shopping websites make online shopping services available to customers via a website. Web shopping centers share similar characteristics with Internet banking websites based on the unique technology they have in common. According to the work of Palmer (2002), user acceptance of WSCs is driven by system factors such as information quality, design, security and functionality of the Web system. On the other hand, the service factors of the Web system include empathy, reliability and responsiveness (Pitt et al., 1995). The information, system and service qualities were introduced by Pitt et al., in their augmented model for IS success. The online features of Web systems can therefore be used to determine the quality of a Web-based system. Online factors such as system quality, service quality and information quality were shown to have a significant impact on user's attitude and behavior to accept and use Web shopping malls as reported in (Ahn et al., 2004). The authors used these major factors to determine user's acceptance of online shopping malls which function as a Web system. Similarly, in Zhang & vonDran 2002, Web quality features such as design, information and service were reported to be the major success features for measuring user acceptance of e-commerce.

The Information quality of an information system (IS) has to do with the characteristics and quality of the output offered by that IS (Stacie & McLean 2009). Previous studies have categorized these characteristics into completeness, accuracy, currency (Gorla et al., 2010), timeliness, usability, conciseness and understandability (Stacie et al., 2008). These characteristics can be attributed to Web shopping centers. DeLone and Mclean (2003) opined that the success of an IS depended greatly on the information quality offered by such system while Kim et al., (200) opined that information quality can also affect trust. Information quality can enable customers choose and easily use online shopping websites. Thongpapanl & Ashraf (2011) reported that the long term survival and profitability of web retailers does not depend on the amount of information provided on the site, rather the relevance, clarity and accessibility of information which influences customer satisfaction and purchase intention positively, especially when the information is customized to the individual, thereby increasing sales performance. We can therefore relate the success of Web shopping centers to the information quality offered by the Web systems provided by WSC providers. Furthermore, the success of an IS depends also on the acceptance of the IS hence, information quality can be used as a factor to determine the acceptance of WSCs.

A Web shopping center can be viewed as an IS therefore, system quality can be a factor in determining the acceptance of online shopping websites. The system quality of Web systems has to do with the engineering and technical quality of the online shopping site which might be the responsiveness of *FULafia Journal of Science & Technology Vol. 2 No. 1 March, 2016*  the Internet shopping website, content layout, ease of learning, ease of use, availability and other system metrics (Ives et al., 1983, Lin & Lu 2000, Liu & Arnett 2000, Ranganathan & Ganpathy 2002) among others. System quality of a web site has to do with the overall operational efficiency of the information system (Ahn et al., 2004, Boudhayan, et al., 2010, Karim 2011). This can be the amount of time it takes to carry out an online shopping transaction on the website or the amount of information to enable easy navigation. The layout of an online shopping platform can determine how long it might take a user to understand how to use the platform efficiently. System quality also has to do with the operational bugs experienced when using an IS (Gorla et al., 2010), therefore in terms of online shopping websites, the operational bugs experienced by users can be a factor affecting usage and acceptance of online shopping websites. These bugs can be in the form of error messages when carrying out an online transaction thereby bringing to the fore, issues the user is unable to deal with. Proper documentation is also another factor attributed to system quality (Gorla et al., 2010) since it enhances ease of learning (Stacie et al., 2008). An online shopper who has access to a favorable set of support tools such as online support chat on the website, demos and well documented help pages is more likely to use Web shopping centers.

In the context of information systems, an organization usually aims to provide to users a service or services that are of high quality. In the context of e-commerce, service quality deals with the mechanisms put in place by Web retailers to ensure that users have high quality experience in their use of Web shopping centers. The factors usually used as a scale for guaranteeing service quality are responsiveness, reliability, assurance and empathy (Pitt 1995, Stacie & Mclean 2009). The amount of time a Web retailer takes to resolve an online shopping issue will determine the Web retailer's reliability and responsiveness in handling customer related complaints thereby giving them a competitive edge over other Web retailers (Dalhatu et al., 2014). Service quality plays an important role because online shopping eliminates face-to-face transactions which call for multiple communication methods to be put in place to handle user complaints and also assist users in efficiently utilizing the services on the online shopping website (Bhattacherjee 2001, Ahn et al., 2004). Therefore service quality can affect the overall acceptance of Web shopping centers by users.

In order to understand the user acceptance behaviors of different forms of technologies, several acceptance models have been developed with the technology acceptance model (TAM) (Davis 1989) being widely and commonly used to investigate user acceptance of various forms of Internet technology driven applications. TAM opines that the use of a system is influenced by user's behavioral intention to use the system and this behavioral intension is in-turn influenced by user's attitude to use the system. As we also stated earlier, Web shopping centers (WSCs) constitute a Web system which enables customers to complete online shopping transactions as they will normally do in a traditional shopping center. Since there is no face-to-face interaction between the Web retailer and the customer, the only medium of communication is the user interface provided by the website. It is therefore not out of context to seek to understand customer's requirements and expectations from their use of the shopping website in order to serve them better. A customer's positive attitude towards using the shopping website significantly and positively influences his behavioral intention to continue using the website.

Previous studies have adopted the TAM in understanding technology acceptance among users especially in the domain of Internet technologydriven applications in recent times (Lin & Lu 2000, Lederer 2000, Bhattacherjee 2001, Ahn *et al.*, 2004, Kim *et al.*, 2008, Raida & Neji 201) and many others. However, this has seen TAM being extended to include other external constructs. Wu & Wang (2004) integrated the extended technology acceptance model (TAM2) by (Vankatesh & Davis 2000) with the innovation diffusion theory (IDT), risk and cost in order to study the acceptance of mobile commerce. Wu & Chen (2005) extended TAM by integrating it with the Theory of Planned Behavior (TPB) in order to study the acceptance of online tax in Taiwan.

As aforementioned, TAM has been subjected to several modifications that gave birth to different models. Some of these modifications revolve around the inclusion of external constructs or variables that IS researchers argue can further develop TAM and make it more sustainable. For instance, we mentioned that online quality features such as information quality, system quality and service quality have been used as external constructs to successfully explore user acceptance behavior via TAM. Therefore, adopting TAM as a model and as a theoretical foundation towards exploring the acceptance of Web shopping centers in Nigeria is a justified approach since TAM allows the introduction of external variables in determining user acceptance of technology. We align our work with that of (Ahn et al., 2004).

In Figure 1, we present the research model for this pilot study. The model is part of the original model proposed by (Ahn *et al.*, 2004) to include offline features of Web shopping centers (WSCs). The offline features are based on marketing views while online *FULafia Journal of Science & Technology Vol. 2 No.1 March*, 2016 features are driven by information system (IS) views. In this initial study, we focus on exploring the online features of WSCs as they relate with technology acceptance model (TAM) constructs. We therefore did not include offline features. The conceptual model combines the popular TAM as formulated in (Davis 1989) and online features as developed and validated in (Barnes & Vidgen 2001; Palmer, 2002; Ranganathan & Ganapathy 2002; Ahn et al., 2004). This study relied on some of the major constructs of TAM which include perceived ease of use (PEOU), perceived usefulness (PU), attitude and behavioral intension to use (BIU) in exploring the relationships between external variables and customer's acceptance of WSCs. This work set out to empirically validate the online features in a Nigerian situation. The basis of the research analysis is therefore the Nigerian user of Web shopping centers and our sample population includes all categories of people who transact with various Web shopping centers.



Figure 1: Research Model

#### **Measurement Development**

The questionnaire was the survey instrument used for data collection. The measurement items in the questionnaire were formed based on the 7-point Likert scale. Measurement items for the Web quality constructs were originally formulated and validated in (Barnes & Vidgen 2001, Palmer 2002, Ranganathan & Ganapathy 2002) as major instruments for measuring the online quality factors.

We adopted the measurement items given in (Ahn *et. al.*, 2004) in order not to reinvent the way, and excluded sub-measurement items that reported a low reliability score. Some of the statements were rephrased as we deem fit. We equally adopted the original TAM constructs and other related measurements from (Davis 1998, Lederer *et al.*, 2000, Lin & Hu 2000, Ahn *et al.*, 2003, 2004). The resulting questionnaire consists of 46 measurement items, all of which measure the seven (7) variables in this study. Table 1 and Appendix A presents the final questionnaire for online features and TAM constructs respectively.

Table 1: Principal Constructs and MeasurementItemsAdapted from Ahn et al., (2004)

Constructs	Measurement Item(s)	Statement(s)
System quality	Design	The Shopping Website has an appropriate style of design for business type
	Navigation	The Shopping Website has an easy navigation to information
	Response time	The Shopping Website has fast response and transaction processing
	System security	The Shopping Website keeps transactions secure from exposure
	System availability	I can use the Shopping Website when I want to use it
	Functionality	The Shopping Website has a good functionality relevant to site type
	Error free transaction	The Shopping Website keeps error- free transactions
	Multimedia	The Shopping Website provides an appropriate video-audio presentation
Information quality	Contents variety	The Shopping Website has sufficient contents which I expect to find
	Complete information	The Shopping Website provides complete information
	Detail information	The Shopping Website provides detailed information
	Accurate information	The Shopping Website provides accurate information
	Timely information	The Shopping Website provides timely information
:	Reliable information	The Shopping Website provides reliable information
	Appropriate format	The Shopping Website communicates information in an appropriate format
Service quality	Responsiveness	The Shopping Website anticipates and responds promptly to user request
	Reliability	The Shopping Website can be depended on to provide whatever is promised
	Confidence	The Shopping Website instils confidence in users and reduces uncertainty
	Empathy	The Shopping Website understands and adapts to the user's specific needs
	Follow-up service	The Shopping Website provides follow-up service to users
	Competence:	The Shopping Website gives a professional and competence image
	Reliability	The E-banking Website can be depended on to provide whatever is promised
	Confidence	The E-banking Website instils confidence in users and reduces uncertainty
	Empathy	The E-banking Website) understands and adapts to the user's specific needs
	Follow-up service	The E-banking Website provides follow-up service to users
	Competence:	The E-banking Website) gives a professional and competence image

#### **Online Survey**

Since we intend to undertake a wider study which would enable us make a more meaningful generalization of the case of Nigeria as we would be targeting Nigerian online users after this current pilot study is concluded, we employed a Web-based survey for this study using Lime Survey tool. We recruited volunteers from within the university who have actually engaged in shopping online. In order to respond to the questionnaire, the respondents were invited to the computer science laboratory during scheduled days and times. Others who could not fill in the survey during the scheduled period were given another convenient schedule. We targeted all the major Web shopping centers in Nigeria. The questionnaire opens with a set of instructions to guide the respondents. Respondents were specifically asked to respond to all the statements based on their individual online shopping experiences. They were also instructed to respond to the statements using the Likert scale of 1-7; where 1 corresponds to "strongly disagree" and 7 corresponds to "strongly agree".

A total of fifty one (51) respondents were recruited, resulting in 51 recorded cases and with no missing values. The cases were first harvested from Lime Survey into a CSV file. The CSV file was then imported into SPSS for initial data pre-processing. The resulting data was then saved as an SPSS file for onward importation into LISREL 9.2 for actual data analysis. Due to the small sample involved, analysis with LISREL software was deemed inappropriate (Chin 1998, Gefen et al., 2000]. We however relied on SPSS and SPSS AMOS for data analysis. Table 2 shows the descriptive statistics of respondent's profile. About 41 percent of the respondents were male. Majority of the participants were between the ages of 20-29. It is important to emphasize that respondents were carefully selected based on our preliminary interviews which showed that they actively shop online. The data collected therefore, is a reflection of the opinions of actual online shoppers

Measure	Item	Frequency	Percentage (%)
Total		51	100.00
Gender	Male	30	41.18
	Female	21	38.18
Age	Below 20	1	1.96
	20-29	28	54.90
	30-39	18	35.10
	Over 40	4	7.84
Occupation	Student	15	29.41
	Private Sector Worker	3	5.88
	Civil Servant	22	43.14
	House-wife	1	1.96
	Self-employed	10	19.60
Primary place of Internet use	Home	25	49.02
	Office	23	45.10
	Other	3	5.88
Degree of Internet experience	Under 1 Year	1	1.96
	1-4 years	12	23.53
	Over 4 years	38	74.51
Preferred Web Shopping Center	Konga	20	39.22
	Jumia	29	56.86
	Kaymu	1	1.96
	Other		
	1		
	1.96		

We emphasize the fact that the respondents were recruited mainly from within the University. This implies that a respondent has the freedom of either choosing to be captured as a student, staff of the university who in this case is a civil servant, a student who could be working in the private sector, a student who could be self-employed or a student who could be a housewife. We chose these professions to reflect the set of respondents we can have in a university domain. We hope to maintain these set of professions for our future wider survey. It is therefore not out of place to find that majority of the participants are civil servants and students who mainly shop online at home and in the office. The difference between participants who do online shopping at home or the office is negligible. A large proportion of the respondents have a considerable degree of Internet experience of over 4 years. The two competing Web shopping centers of choice are Jumia and Konga, with Konga up ahead by 18 percent.

#### **RESULTS AND DISCUSSION**

The conceptual model was analyzed using IBM's SPSS Statistics 20 and IBM's SPSS AMOS 23 software. Maximum likelihood approach was used in estimating the research model. We performed data analysis in two phases. In the first phase, the measurement model was subjected to a critical examination and validation. In the second phase, we performed a structural equation model analysis which is supported in SPSS Amos via path coefficient analysis. This is in order to test the relationships between the constructs in the research model.

#### **The Measurement Model**

Our sample data was tested for suitability for factor analysis and the result showed a KMO and Bartlett's test values which were below the recommended values. This again we mainly attributed to the small sample size involved. Exploratory factor analysis (EFA) and LISREL analysis was therefore discontinued. We hope to employ LISREL analysis in our future wider study that will accommodate a larger sample size.

A reliability test is usually given as a measure of the degree of consistency between measurement items corresponding to a scale (Pallant 2004). We used Cronbach's alpha coefficient to measure the internal consistency of the scale. According to (Nunnaly et al., 1994), a reliability score of 0.70 can be accepted as a minimum though [Lance et al., 2006] argued that this acceptable minimum can also be misleading. A review of past literature shows 0.70 is the most common acceptable minimum score and we have adopted it as a standard in this study. The computed Cronbach alpha for each of the items measured and their descriptive statistics is given in Table 3. Due to the small sample size and also low item-total results, we dropped the following measurement items: SYSQ8 (multimedia) for system quality, PEOU1, PEOU2 and PEOU5 for ease of use construct. All constructs indicated a reliability of above 0.80 except system quality and attitude which have 0.776 and 0.773 respectively. The reliability of the scale was therefore found to be sufficient

Table 3: Reliabilities and Descriptive Statistics f	or
Principal Constructs	

Constructs	Measurement item(s)	Cronbach's alpha	Mean	Standard deviation
System Quality	SYSQ1	0.776	43.64	3.95
	SYSQ2			
	SYSQ3			
	SYSQ4			
	SYSQ5			
	SYSQ6			
	SYSQ7			
Information Quality	INFQ1	0.860	44.04	3.88
	INFQ2			
	INFQ3			
	INFQ4			
	INFQ5			
	INFQ6			
	INFQ7			
Service Quality	SERQ1	0.843	35.71	4.04
	SERQ2			
	SERQ3			
	SERQ4			
	SERQ5			
	SERQ6			
Perceived Ease of Use	PEOU1*	0.824	24.50	3.80
	PEOU2*			
	PEOU3			
	PEOU4			
	PEOU5*			
	PEOU6			
	PEOU7			
Perceived Usefulness	PU1	0.874	43.35	4.88
	PU2			
	PU3			
	PU4			
	PU5			
	PU6			
	PU7			
Attitude	AU1	0.773	32.35	3.27
	AU2			
	AU3			
	AU4			
	AU5			
Behaviour	BIU1	0.820	30.37	3.89
	BIU2			
	BIU3			
	BIU4			
	BIU5			

\*Dropped measurement items

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Table 4 shows the correlation matrix for the 7 principal constructs. We found significant correlations between most of the variables under consideration. There were no significant correlations between system quality and perceived ease of use (PEOU), perceived usefulness and (PU) and PEOU, PU and attitude and lastly, PEOU and behavior.

#### Table 4: Correlation Matrix

	Cronbach Alpha	SysQuality	InfoQuality	Ser Quality	PEOU	PU	Attitude	Behaviour
SysQuality	.776	1						
InfoQuality	.860	.488** .000	1					
SerQuality	.860	.630** .000	.624** .000	1				
PEOU	.824	179	289 *	-372**	1			
		.209	.039	.007				
PU	.874	.539**	.560**	.429**	071	1		
		.000	.000	.002	.620			
Attitude	.773	.418**	291*	.372**	106	.662**	1	
		.000	.038	.007	.459	.000		
Behaviour	.820	.414**	.426**	.344**	. 024	.559**	415**	1
		.003	.002	.013	.867	.000	.002	

\*\* Correlation is significant at the 0.01 level (2-tailed) \*Correlation is significant at the 0.05 level (2-tailed)

#### **Structural Model**

We proceeded with path coefficient analysis to test the general model fit. Table 5 presents a summary of the overall model fit indices for the proposed research model. Again, due to the small sample size, we did not expect our Chi-square value to be high. A  $\chi 2$  value of 7.008, with 7 degrees-of-freedom and at a significance level of 0.428 was obtained. This is considered quite significant. The values for GFI, CFI and NFI were above the recommended value of 0.90. The RMSEA equaled 0.005 which is acceptable. We then went on to assess the estimated coefficients between the various constructs in our proposed model. The results are presented in Figure 2.

Table 5: Fit Indices for the Structural Model
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Measure	Research model	Acceptable cut-off values (Ives <i>et al.</i> 1983)
Absolute fit measures		
Chi-square ()	7.008	Better to be lower
Degrees of freedom	7	
Significance level	.428	
Goodness-of-fit index (GFI)	.963**	>.090
Root mean square residual (RMSR)	.005**	<.08
Baseline comparisons		
Adjusted goodness-of-fit index (AGFI)	.851*	>.090
Normed fit index (NFI)	.951**	>.090
Tucker-Lewis index (TLI)	1.000**	>.090
Comparative fit index (CFI)	1.000 **	>.090
Parsimony-adjusted measures		
Parsimony normed fit index (PNFI)	.317*	Higher values are better
Parsimony comparative fit (PCFI)	.333*	Higher values are better

Acceptable thresholds: \*(marginal), \*\*(acceptable)



Figure 2: Structural model fit

Following from the structural model in Figure 2, we deduce the following; system quality indicates a strong significant relationship with perceived usefulness ( $\beta$ =0.11, p<0.01) and not so strong a relationship with perceived ease of use. This is also indicated by the low value of R-square for PEOU. Information quality showed a strong significant relationship with both perceived usefulness ( $\beta$ =0.43, p<0.01) and perceived ease of use ( $\beta$ =0.37, p<0.01). Service quality rather indicate an unexpected strong negative influence on perceived ease of use ( $\beta$ =-0.37, p<0.01) and an equally unexpected but not so strong negative influence on perceived usefulness. Perceived usefulness shows a strong significant relationship with both attitude ( $\beta$ =0.66, p<0.01) and behavioral intension ( $\beta$ =0.51, p<0.01). We obtained a rather negative relationship between perceived ease of use and attitude, and that

between perceived ease of use and perceived usefulness, between attitude and behavior were rather not so strong in significance. Information quality indicated a higher impact on usefulness and behavioral intention to use Web shopping centers amongst the entire external variables considered. We expected to see a strong significant and positive relationship between perceived ease of use (PEOU) and both service quality and attitude; instead the reverse is the case. This quite poor showing by PEOU is consistent with the result of the poor correlations between PEOU and attitude, PEOU and service quality, PEOU and system quality.

Based on our small sample data and the results obtained, TAM produced outcomes which are to some extent are quite consistent with testing the behavioral intention of customers to use Web shopping centers. The attitude towards using Web shopping centers for example, has a great impact on user's behavior to use shopping websites. Customer's attitude is known to be mediated by his or her perceived ease of use and perceived usefulness. Again following from Figure 2, we observed that only perceived usefulness greatly influenced attitude while ease of use had a poor showing. These result are consistent with the submissions of Lin et al., (2000) and Ahn et al., (2004), thereby confirming that perceived usefulness has a greater and significant relationship with perceived ease of use, and perceived ease of use has a greater and significant impact on perceived usefulness. By implication, perceived usefulness will continue to remain a major determinant of shopping website usage while perceived ease of use will indirectly affect user's intention to use shopping websites. We therefore reason that perceived usefulness is influenced by perceived ease of use. In the same vein, users who find it easy to use shopping websites will equally find Web shopping centers very useful.

The results so far obtained in this initial study shows that online shoppers have identified with online features of shopping websites and some our outcomes are quite consistent with similar research reported in (Ahn *et al.*, 2004). In the online shopping domain, the online shopper represents a system user. The online features of any shopping website play a very significant role in determining the behavioral intention of customer's continuous use of the Web shopping center.

#### CONCLUSION

This results explore the online quality features of Web shopping centers with respect to customer acceptance behavior towards adopting online shopping websites. It specifically adopted and revised the conceptual model developed by (Ahn *et al.*, 2004) by establishing relationships between online features of shopping websites and excluding the offline features thereby

focusing only on IS views. We particularly used their model in a Nigerian context. The outcome of our work shows that customers recognize the role online features of shopping websites play in predicting their acceptance of online shopping. The results indicate that online features have positive and significant impact on customer's perceived usefulness and perceived ease of use.

The result we obtained from this pilot survey indicates that online shoppers think shopping websites to be virtual representations of the traditional shopping centers. The online quality features affect the capacity of shopping website providers to retain online shoppers. Providers therefore need to improve the online features of their online shopping platforms in order to boost patronage and also compete favorably.

Our main contributions are that we were able to extend and apply the online quality factors to the Nigerian situation. We specifically carried out an empirical measurement of online quality features as they affect user's behavioral acceptance of Web shopping centers. Based on our sample data, we showed to an acceptable degree that online quality factors significantly impacts customer acceptance of Web shopping centers.

This work is limited by the small sample size of 51 respondents we analyzed. The sample size we relied on means that we are unable to generalize our research findings in order to relate it to the real Nigerian population. The small sample size used also means that we were also unable to perform further advanced statistical data analysis using advanced software like LISREL. This also implies that we cannot generalize the results so far obtained. More so, the respondents recruited were mainly from one sample location which is the university. We intend to recruit respondents who would reflect a wider opinion of the Nigerian population in order to improve the performance figures in our future study.

Based on what we have learnt from this initial study, our future work would be to undertake a wider study. We would aim to recruit up to 1000 or more actual online shoppers to participate in our survey. This will enable us perform better analysis and put us in full position to generalize our research findings. It is also possible to include other external variables such as trust and even use other variations of TAM in exploring user acceptance behaviors.

### Appendix A: Adapted and revised from Ahn et al., (2004)

### A. 1. Perceived ease of use

PEOU1:Learning to use this shopping website is easy for me PEOU2: It will be impossible to use this shopping website without expert help PEOU3: My interaction with this shopping website is clear and understandable PEOU4:It is easy for me to become skillful at using the shopping website PEOU5:Using the shopping website requires a lot of mental effort PEOU6:I find it easy to get the shopping website to do what I want it to do PEOU7:I find the shopping website user friendly

### A.2. Perceived Usefulness

PU1:Using this shopping website enables me to accomplish tasks more quickly

PU2:Using this shopping website helps me to get better decision

PU3:Using this shopping website improves the performance of my tasks

PU4:Using this shopping website saves me money

PU5:Using this shopping website increases my task productivity

PU6:Using this shopping website improves my task quality

PU7:Using this shopping website makes my job easier

### A.3. Attitude to use

AU1:Using the shopping website is a good idea

AU2:Using the shopping website is a wise idea

AU3:Using the shopping website is satisfactory idea

AU4:Using the shopping website is a positive idea

AU5:Using the shopping website is an appealing idea

### A.4. Behavioral Intention to Use

BIU1:I will keep use of this shopping website in the future

BIU2:I will use this shopping website on a regular basis in the future

BIU3:I will frequently use this website provider in the future

BIU4:I will use this shopping website rather than other shopping websites for shopping

BIU5:I will recommend others to use this shopping website

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### REFERENCES

- Ahn, T., Ryu, S. & Han, I. (2004). The impact of the online and offline features on the user acceptance of Internet shopping malls. *In Electronic Commerce Research and Applications*. pp. 405–420.
- Aladwani, A. M., Palvia, P.C., (2002). Developing and validating an instrument for measuring user-perceived Web quality, *Information and Management*, 38:467–476.
- Aminu, S. A. (2013) Challenges Militating against Adoption of Online Shopping in Retail Industry in Nigeria. *Journal of Marketing Management*, 23-33.
- Ayo, C. K. (2011). Business-to-consumer e-commerce in Nigeria: Prospects and challenges. *African Journal* of Business Management, 5109-5117.
- Barnes, S. & Vidgen, R., (2001). An evaluation of cyber-bookshops: the WebQuality method. *International Journal of Electronic Commerce*, 6(1), pp.11–30. Available at: Bhattacherjee A., 2001. An
- empirical analysis of the antecedents of electronic commerce service continuance, *Decision Support Systems* 32, 201–214.
- Chen, L., Gillenson, M. L. and Sherrell, D. L., (2002). Enticing online consumers: an extended technology acceptance perspective, *Information and Management*, 39: 705–719.

Chin, W.W., (1998) Issues and Opinion on Structural Equation Modeling. MIS Quarterly, 22(1), p.1.

- Davis, F.D., (1989). Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly*, 13(3), pp.319–340.
- Gefen, D., Straub, D. & Boudreau, M. (2000). Structural equation modeling and regression: Guidelines for research practice. Communications of AIS, 4(October).
- Gefen, D., Karahanna E.and Staub, D.W., (2003). Trust and TAM in online shopping: an integrated model, *MIS Quarterly*, 27 (1) 51–90.
- Gorla, N., Somers, T.M. & Wong, B., (2010). Organizational impact of system quality, information quality, and service quality. *The Journal of Strategic Information Systems*, 19(3), pp.207–228.
- Ives, B., Olson, M.H. & Baroudi, J.J., (1983). The measurement of user information satisfaction. Communications of the ACM, 26(10), pp.785–793.
- Keeney R. L. (1999). The value of internet commerce to the customer, Management Science 45 (4) 533-542.
- Kim, D. J., Ferrin, D.L. & Rao, H.R. (2008). A trust-based consumer decision-making model in electronic commerce: The role of trust, perceived risk, and their antecedents. *Decision Support Systems*, 44(2), pp.544–564.
- Koufaris, M., Kambil A., LaBarbera P. A., (2002) Consumer behavior in Web-based commerce: an empirical study, *International Journal of Electronic Commerce*, 6 (2)115–138.
- Lance, C.E., Butts, M.M. & Lawrence, C.M., (2006). The Sources of Four Commonly Reported Cutoff Criteria: What Did They Really Say? Organizational Research Methods, 9(2), pp.202–220.
- Lederer, A., Maupin D. J., Sena M.P., Zhuang Y., (2000). The Technology Acceptance Model and the World Wide Web. *Decision Support Systems*, 29, pp.269–282.
- Lin, J. C. & Lu, H., (2000). Towards an understanding of the behavioural intention to use a web site. *International Journal of Information Management*, 20(3), pp.197–208.
- Nunnally, J. C. & Bernstein, I. (1994). Psychometric Theory, Sydney: McGraw-Hill. Olajubu E. 2009. A Customized e-Shopping System for SMEs in Developing Countries: Cases from the Sub Saharan Desert of Africa. *The International Journal on Advances in ICT for Emerging Regions*, 38-46.
- Osotimehin K., Hassan B., Ariyo O. O.(2015). Attitude and perception of consumers to online shopping. *Ago-Iwoye Journal of Social and Behavioural Sciences*, 41-63.
- Pallant, J., (2004). SPSS survival manual, London: Open University Press, Mcgraw-Hill. Palmer, J.W., (2002). Web site usability, design, and performance metrics. *Information Systems Research*, 13(2), pp.151–167.
- Petter, S., DeLone, W. & McLean, E., (2008). Measuring information systems success: models, dimensions, measures, and interrelationships. *European Journal of Information Systems*, 17(3), pp.236–263.
- Petter, S. & McLean, E.R., (2009). A meta-analytic assessment of the DeLone and McLean IS success model: An examination of IS success at the individual level. Information and Management, 46(3), pp.159–166.
- Pitt L. F., R. T. Watson, Kavan C. B., Service quality: a measure of information systems effectiveness, MIS Quarterly 19 (2) (1995) 173–187.
- Raida, R. E. & Néji, B., (2013). The Adoption of the E-Banking: Validation of the Technology Acceptance Model. *Technology and Investment*, 04(August), pp.197–203.
- Ranganathan, C. & Ganapathy, S., (2002). Key dimensions of business-to-consumer web sites. *Information* and Management, 39(6), pp.457–465.
- Thongpapanl N. & Ashraf A.. (2011). ENHANCING ONLINE PERFORMANCE THROUGH WEBSITE CONTENT AND PERSONALIZATION. Journal of Computer Information Systems, 3-13.
- Torkzadeh, G. and Dhillon G., Measuring factors that influence the success of internet commerce, Information Systems Research 13 (2) (2002) 187–204.
- Venkatesh, V. & Davis, F., (2000). Theoretical extension of the Technology Acceptance Model: Four longitudinal field studies. *Management science*, 46(2), pp.186–204.
- Wu, I. L. & Chen, J.L., (2005). An extension of Trust and TAM model with TPB in the initial adoption of on-line tax: An empirical study. *International Journal of Human Computer Studies*, 62(6), pp.784–808.
- Wu, J. & Wang, S., (2005). What drives mobile commerce? Information & Management, 42(5), pp.719–729.
- P. Zhang, G. M. vonDran, User expectations and rankings of quality factors in different Web site domains, International Journal of Electronic Commerce, 6 (2) (2001–2002) 9–33





# PHYSICAL SCIENCES

## NEQUICK MODEL PREDICTIONS AND THE OBSERVED TOTAL ELECTRON CONTENT (TEC) OVER NIGERIA

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#### ABSTRACT

The Sun and its various activities such as coronal mass ejection (CME), solar flare, and solar wind is the major driver of the magnetosphere processes that have a strong bearing on the ionosphere. The equatorial ionosphere is in a constant state of perturbation because of the parallel alignment of the geomagnetic field with the surface, this is termed equatorial ionosphere anomaly. This resulted in the east - west electromagnetic field drift which is known as equatorial electrojet and the night time occurrence of scintillation/plasma bubble which is a major challenge to effective utilization of global navigation satellite systems (GNSS) especially in the equatorial region for navigation, positioning and communication. Various models have been established in the prediction of ionospheric processes and perturbations in order to establish the stability and effectiveness of modern technologies which rely solely on the ionosphere. One of such models is the NeQuick2 of the International Centre for Theoretical Physics (ICTP) Trieste which is use to predict the state of the ionosphere and it Total Electron Content (TEC). Effort were being made in this work to compare NeQuick2 model prediction with the observational data obtained from Nigeria GNSS network of two stations in Nigeria namely Enugu (UNEC) and Zaria (ABUZ). The research examines TEC during both intense geomagnetic storm period and quiet period over the two GNSS stations in Nigeria. It was discovered that NeQuick2 model may not accurately predict TEC behaviour over Nigeria, situated in the region of equatorial ionosphere anomaly. The implications are further discussed.

Keywords: Geomagnetic storm, GNSS, Equatorial ionosphere, Ionosphere models
### **INTRODUCTION**

The Sun and its various activities (Figure 1 and 2) such as coronal mass ejection (CME), solar flare, and solar wind is the major driver of the magnetosphere processes that have a strong bearing on the ionosphere. The ionosphere is the region of the upper atmosphere where sufficient ionized species (electrons) exist to affect radio waves propagation (Kutiev et al., 2013). The structure and shape of the ionosphere is driven mainly by solar activity. The equatorial ionosphere is in a constant state of perturbation because of the parallel alignment of the geomagnetic field with the surface. This resulted in the east - west electromagnetic field drift which is known as equatorial electrojet and the night time occurrence of scintillation/plasma bubble that poses a major challenge to effective utilization of global navigation satellite systems (GNSS) especially in the equatorial region for navigation, positioning and communication (Buonsanto, 1999). Fluctuations in the total electron content cause ionospheric delay that resulted in GNSS positioning error (Omojola and Abimbola, 2015). Various models have been established in the prediction of ionospheric processes and perturbations in order to establish the stability and effectiveness of modern technologies which rely solely on the ionosphere. One of such models is the NeQuick2.

NeQuick gives an analytical representation of the vertical electron density profile. It was developed by the International Centre for Theoretical Physics (ICTP) Trieste, Italy and the Institute for Geophysics, Astrophysics and Meteorology university of Graz, Austria (Nava, 2014, Coisson et al., 2008) as a quick run model tailored for trans- ionospheric propagation applications. It is an empirical model mainly driven by the monthly average solar flux (F10.7) and the ionospheric F2 peak parameters computed by the International Telecommunication Union (ITU) foF2 and M (3000) F2 models (ITU R - 1995). Recently, NeQuick version 1 was substituted for NeQuick2 and is the one currently recommended by ITU (ITU - R P.531 - 12) the package include routine to evaluate the electron density along any ground – to – satellite ray path and also estimate the corresponding total electron content by numerical integration (Nava et al.,2008, Radicella, 2009).

GNSS signal measurements interaction with the ionosphere has become one of the major tools for the estimation of total electron content along satellite – to – receiver ray path (Minkwitz *et al.*, 2015, Nava, 2008). The range error of GNSS signals correspond to the total electron content (TEC) along propagation path, it is dependent on frequency (F) of propagation according to equation 1

Range error = 
$$\frac{\pm 40.3TEC}{F^2}$$
 (m) .....1

Total electron content is the total number of electrons in a unit square meter cross sectional area along satellite – receiver ray path (Equation 2)

$$TEC = \int_{R}^{S} N_{e} ds \qquad \dots 2$$

TEC is usually expressed in total electron content units (TECU), 1 TECU is equivalent to 10 16 electrons/m<sup>2</sup> Ne is the total number of electrons in each square meter area through the differential distance (ds) along satellite receiver ray path.

The equatorial ionosphere of African sector in general, is an area which has the largest land mass that fall within the equatorial ionosphere anomaly region with a complex electrodynamics morphology which is yet to be fully understood (Tariku, 2015)



Figure 1: Active Sun



Figure 2: Quiet Sun

(Figure 1 and 2 was adapted from the website of international space weather initiative (ISWI)) This work seeks to validate NeOuick 2 model with observational data obtained from Nigeria GNSS network over the two stations during intense geomagnetic storms and a geomagnetically quiet period. It is always a necessity to validate empirical models with the observational data sources.



Figure 3: Map of Nigeria showing the location of the two Nignet stations

# MATERIALS AND METHODS

The three (3) selected storms for this can be classified as intense. Standard nomenclature for intense storms usually have disturbance storm time (Dst-index) minimum of less than (Stankov et al., 2010). The Dst-index data for storm period and the quiet time was downloaded from World Data Centre for geomagnetism (WDC) Kyoto, Japan (wdc.kugi. kyoto-u.ac.jp/dst) which was corroborated by the International Quiet Day (IQD) and international Disturbed Days (IDD) data from Geosciences Australia website (www.ga.gov.au/oracle/geomag/ igd form.jsp). Daily RINEX file data for the selected quiet day and storm day were downloaded from Nigeria GNSS stations website (server.nignet.net/ data). The two stations are Zaria (ABUZ: Latitude; 11.1517°E, Longitude; 7.6486°N) and Enugu (UNEC: Latitude; 6.4237°E, Longitude; 7.5048°N) both located in Nigeria (Figure 3). NeQuick2 estimated VTEC was obtained from the website (http://t-ict4d. ictp.it/nequick2 )

Gopi GPS – TEC analysis software version 2.9.3 was used to estimate the vertical total electron content (VTEC) over the stations. The NeQuick 2 model VTEC was plotted over the GNSS VTEC observed over the two stations for both storm period and quiet time using Matlab for further analysis in order to validate NeQuick 2 VTEC estimation with the observational data over the two stations.

The Percentage deviation was calculated using the relation in equation 3

$$\% devuation = \frac{Observation VTEC - NeQuick2 VTEC}{Observation VTEC} X 100 \dots 3$$

# **RESULTS AND DISCUSSION**

Vertical TEC (VTEC) as estimated by NeQuick2 model and the GNSS observational data (GPS – VTEC) was plotted with the disturbance storm time (Dst) on a three panel plots for the two stations (Figure 4, 5, 6, 7, 8, 9). The NeQuick2 model generally under estimate TEC in the noon period for both geomagnetically disturb period and quiet period which agrees with Coisson *et al.*, (2008) that NeQuick model underestimate TEC in the equatorial region, but this work reveal that NeQuick2 also over estimate TEC in the pre noon and post noon period over the two stations in Nigeria which a higher value during the geomagnetically quiet day.

### a. ABUZ STATION



Figure 4: GNSS and NeQuick2 VTEC plots for the intense geomagnetic storm and the quiet period in October 2011 at ABUZ



Figure 5: GNSS and NeQuick2 VTEC plots for the intense geomagnetic storm and the quiet period in October 2012 at ABUZ



Figure 6: GNSS and NeQuick2 VTEC plots for the intense geomagnetic storm and the quiet period in October 2013 at ABUZ

### b. UNEC STATION



Figure 7: GNSS and NeQuick2 VTEC plots for the intense geomagnetic storm and the quiet period in October 2011 at UNEC



Figure 8: GNSS and NeQuick2 VTEC plots for the intense geomagnetic storm and the quiet period in October 2012 at UNEC



Figure 9: GNSS and NeQuick 2 VTEC plots for the intense geomagnetic storm and the quiet period in October 2013 at UNEC

There is no much difference between the model predictions during intense geomagnetic storm and during quiet period which means the model may not give accurate prediction of the geomagnetic storm effect.

The model may still not be able to include accurate solar flux parameter of the equatorial region of African sector and the seasonal and diurnal variation in the equatorial ionosphere electrodynamics.

Percentage deviations over the two stations show a higher pre – noon and post noon over estimation for the geomagnetically quiet day (Figure 10, 11, 12, 13, 14 and 15) with the highest occurring in the March (Figure 12 and Figure 15).



Figure 10: Hourly Percentage deviation over ABUZ during the storm day and quiet day in October, 2011



Figure 11: Hourly Percentage deviation over ABUZ during the storm day and quiet day in October, 2012



Figure 12: Hourly Percentage deviation over ABUZ during the storm day and quiet day in March, 2013

### **UNEC Stations**



Figure 14: Hourly Percentage deviation over UNEC during the storm day and quiet day in October, 2011



Figure 13: Hourly Percentage deviation over UNEC during the storm day and quiet day in October, 2012



Figure 15: Hourly Percentage deviation over UNEC during the storm day and quiet day in October, 2013

### CONCLUSION

We have studied Total electron content as predicted by NeQuick 2 model and the GNSS estimated TEC from the observation data. We have also calculated the percentage deviation of the observed Tec from the NeQuick model prediction. It can be inferred that NeQuick 2 model may not yet give an accurate TEC prediction over the equatorial region of African sector.

NeQuick 2 over estimate TEC in the pre-noon and post noon period over the equatorial station of African sector and also under estimate TEC in the noon period. The pre noon and the post noon over estimation are higher during geomagnetically quiet period than during the intense geomagnetic storm for the two stations.

Since range error is directly proportional

to TEC along propagation path (Amit *et al.*, 2010) and 6.15 TECU correspond to 1m range error on L1 frequency and 1.7m range error on L2 frequency. Improper modeling of TEC may have a devastating effect on global navigation satellite systems and all technologies that relied on GNSS in the region under study.

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## REFERENCES

Amit, J., Sunita, T., Sudhir, J., and Gwal, A. K. (2010). TEC response during severe geomagnetic storms near the crest of equatorial ionization anomaly. *Indian Journal of Radio and Space Physics*, 39: 11-24.

Buonsanto, M. J. (1999): Ionospheric Storms, Space Science Reviews, 88,563-601

- Coisson, P., Nava, B., Radicella, S.M, Oladipo, O. A., Adeniyi, J. O., Gopi, S. K, Rama Rao, P. V. S and
- Ravindran S. (2008). NeQuick Bottom side analysis at low latitude, *Journal of Atmospheric and Solar Terrestrial Physics*, 70 1911-1918.
- International Telecommunication Union: Reference Ionosphere Characteristics and methods of Basic MUF, operational MUF and ray path Prediction available at:https://www.itu.int/dms pubre/ itu-r/ rec/p/R-REC-P.434-6 199510-w!!PDF-T.pdf
- Kutiev *et al.*, (2013): Solar activity impact on the Earth's upper atmosphere. *Journal of Space Weather Space Climate*, 3 2013 A06 Doi: 10.105/swsc/2013028.
- Minkwitz D., van der Boogaart K. G, Gerzen T, and Hogue M (2015). Tomography of the Ionosphere electron density with geo-statistical inversion. Annals of Geophysics 33,1071-1079, 2015. doi:10.5194 angeo-33-1071-1079-2015.
- Nava B. (2 December, 2014) NeQuick model: features and Applications United Nations/ICTP workshop on Global Navigation Satellite Systems for scientific application (Trieste, Italy)
- Nava, B., Coisson, P. and Radicella S. M, (2008). A new version of the NeQuick Ionosphere electron density model. *Journal of Atmospheric and solar Terrestrial Physics*. doi:10,1016/j.jastp.2008.01.015
- Omojola, J. and Abimbola, O. J. (2015). GNSS positioning accuracy over Nigeria during geomagnetic storm of 24 27 October 2011 and 7 10 October 2012. *Indian Journal of Radio & Space Physics*, 44:138 146.
- Radicella, S.M (2009). The NeQuick model genesis uses and evolution. Annals of Geophysics 52, N 3/4
- Stankov, S. M., Stegen K. and Warnant R. (2010). Seasonal variation of "Storm time TEC at European middle latitudes". *Advances in Space Research*, 46:1318-1325.
- Tariku Y. A (2015). Pattern of GPS-TEC variation over low latitude regions (African sector)during the deep solar minimum (2008 to 2009) and solar maximum (2012 to 2013) phases. *Earth, Planets and Space Doi*: 10.1186/s40623-015-0206-2





# PHYSICAL SCIENCES

# SPACIO-TEMPORAL VARIATION OF RADIO REFRACTIVITY IN LAFIA, NASARAWA STATE USING CM SAF ATOVS SATELLITE DATA

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### ABSTRACT

Communications using radio waves propagates through the atmosphere and plays a major role in civilization. Vertical variation of radio refractivity in Lafia(  $8.492^{\circ}N$  and  $8.517^{\circ}E$ ) Nigeria,was investigated with a five-year (2010 – 2014) monthly mean atmospheric layered data from the ATOVS (Advanced TIROS (Television InfraRed Observation Satellite) Operational Vertical Sounders) instruments flying onboard the NOAA and Metop-A satellites; this data is provided by the EUMETSAT's Climate Monitoring Satellite Application Facilities (CM SAF). Using the CM SAF data, at six pressure levels (1000hPa, 850hPa, 700hPa, 500hPa, 300hPa and 200hPa), the monthly mean of radio refractivity were estimated and the results analyzed. Also, the diurnal variation of the surface radio refractivity was also investigated using the data from the automatic weather station (model no WS104) installed at the Department of Physics, Federal University Lafia.Results obtained showed that the vertical model of the radio refractivity N, in Lafia could be given as  $N=N_0 \exp(-hA_0)$ , where  $N_0$ , the surface radio refractivity, was found to be approximately equal to 288.1 *N*-units, while the scale height  $h_0$ , was found to be approximately equal to 8.40km; it was found that sub-refraction predominates in Lafia at all seasons. The diurnal range of surface radio refractivity as measured by the *in-situ* weather station was found to be between 325.0 and 365.0 *N*-units, with a maximum in the morning and minimum in the afternoon.

Keywords: Atmosphere, Radio Refractivity, CM-SAF, Lafia Nigeria

## INTRODUCTION

Radio wave is a very important component of our civilization; it is used for point to point communication as well as for data exchange. Radio wave being an electromagnetic wave interacts with the space through which it propagates as it is sent to carry information from one point to the other(Adediji and Ajewole, 2008). This interaction with space generally leads to wave phenomenon such as diffraction, reflection, polarization and refraction.

Refraction is the bending of waves as it passes through different media as a result of changes in the velocity and wavelength of the wave. A measure of this bending is called refractive index (n) and is defined as

$$n = \sqrt{\varepsilon_r} \qquad \dots 1a$$
$$= c/v_{\text{phase}} \qquad \dots 1b$$

where  $\varepsilon_r$  is the dielectric constant of the atmosphere, c is the speed of light and  $v_{phase}$  is the phase velocity of thewave in the medium. The power of a medium to bend waves is called refractivity (*N*) and according to the International Telecommunication Union recommendation (ITU-R, 2009), atmospheric radio refractive index n, is related to the atmospheric radio refractivity *N*, by

The interaction of radio waves with the atmosphere results in refractivity effects such as fading, which results from the bending away/towards the earth of radio waves (Adediji and Ajewole, 2008; Otasowie and Edeko, 2009; Valma *et al.*, 2010).

The main atmospheric component that significantly affects radio refractivity is the water vapor and this is as a result of the polar nature of water. The International Telecommunication Union recommends Eq. 3 for the estimation of refractivity N,

The variation of refractivity with height is modelled according to Eq. 4

 $N_{\rm s} = N_{\rm o} \exp(-\frac{hs}{h_{\rm o}})$  .....4

where  $N_0$  is the average value of atmospheric refractivity extrapolated to sea level,  $h_0$  is the scale height (km) and  $h_s$  is the height above sea level (km). ITU-R (2009) recommended that  $N_0$  and  $h_0$  should be determined statistically for different climates.

A radio link designer will be much interested in the vertical refractivity gradient (G), especially at the lowest 100m from the earth's surface, because it is critical in the estimation of path clearance and propagation effects such as sub-refraction, superrefraction or ducting (Manning, 1999; ITU-R, 2009; Adediji and Ajewole, 2008; Otasowie and Edeko, 2015). Refractivity gradient (G) is defined as

$$G=\Delta N/\Delta h$$

where  $N_s$  is the radio refractivity at an upper height  $h_s$ and  $N_1$  is the radio refractivity at a lower height  $h_1$ . The value of G is usually negative because the radio refractivity decreases with height. From Equation 4, radio refractivity gradient at a given height could also be written as

Another convenient parameter that could be used to quantify the refraction effects is called the effective earth radius factor k (Manning, 1999; Grabner and Kvicera, 2011; Adedijiand Ajewole, 2011; Otasowie and Edeko, 2015) which could be defined as

This research work used four years satellite data from EUMETSAT, CM SAF to study the radio refractivity over Lafia, Nigeria and hence, determine a suitable mathematical model that could be used to describe the radio refractivity and the characteristics of the propagating radio waves through the atmosphere over Lafia. The use of the newly installed automatic weather station at the Physics Department of the Federal University Lafia for the estimation and study of variation in surface radio refractivity was also demonstrated.

### MATERIALS AND METHODS

The upper air data used in this work was obtained from the European Meteorological Satellite (EUMETSAT), Satellite Application Facility on Climate Monitoring (CM SAF, http://www.cmsaf.eu). The CM SAF derives its data products, among others, from the ATOVS (Advanced TIROS [Television InfraRed Observation Satellite] Operational Vertical Sounders) instruments onboard the NOAA (-15 to -19) and Metop-A polar orbiting satellites, since 13th of May 1998. The data products were obtained as a monthly means on a cylindrical equal area projection of 90km X 90km with a global grid resolution of 0.5° X 0.5°, as a result of this grid resolution the nearest data grid (i.e., 8.250 °N; 8.750 °E) to the true geographic grid of Lafia (i.e., 8.492 °N; 8.517 °E) was used. The CM SAF operational data used in this work is the HSH (CM-138, doi: 10.5676/EUM\_SAF\_CM/WVT\_ATOVS/ V001) monthly mean data product at six (6) pressure levels, comprising of specific humidity (in g/kg) and temperature (in K); the six pressure levels are 200hPa, 300hPa, 500hPa, 700hPa, 850hPa and 1000hPa.

The *in-situ* surface measurements were done with the automatic weather station (model no WS104) installed at the Department of Physics, Federal University Lafia (see the inset of Figure 1). The weather station started operation on 1st of April, 2015. The CM SAF, ATOVS data, which was obtained in a NetCDF file format, was processed using Panoply free software while all other data analysis was done with the Microsoft Excel® Spreadsheet package.



Figure 1: Geo-location of the research site (the inset shows the automatic

weather station as installed at the Federal University Lafia).

### **RESULTS AND DISCUSSION**

The variation of radio refractivity, as measured at six different pressure levels, in Lafia is shown in Figure 2, using the average five year (2010 to 2014) data. Figure 2 shows that from the average surface radio refractivity value of ~289.2 *N*-units, the radio refractivity decays exponentially with height and at 12.0km (the top of the troposphere) it has decayed to ~70.0 *N*-units.

Following the ITU recommendation ITU-R P.453-6, an exponential fit that yielded the exponential model of Eq. 8was fitted to the data, with a coefficient of determination R2, of 0.9999. Eq. 8 could be rewritten as Eq. 9, from which it could be seen that the radio refractivity scale height in Lafia is given as 8.55 km and the average surface radio refractivity in Lafia is  $\sim$ 289.2 *N*-units.



Eq. 8 (or 9) is an all season model for Lafia and since radio refractivity strongly depends on atmospheric moisture content it would be of interest to investigate the seasonal variation of radio refractivity. Attempt at doing this yielded Eqs10 and 11 for the wet and dry seasons respectively with coefficient of determinations of 0.9999 and 0.9997.

N=295.9exp(-h/8.40)	)10
$N=283.8\exp(-h/8.62)$	)11

A look at Eqs.10 and 11 clearly shows greater surface refractivity during the wet season than during the dry season, besides the observed radio refractivity scale height during the seasons. The scale height during the wet season (~8.40km) could be seen to be lower than that of the dry season (~8.62km), this is as a result of the dependence of the radio refractivity on the atmospheric moisture content; scale height is inversely proportional to the mass of the atmospheric constituent. During the wet season, there is more water vapor mass hence, lower scale height and during the dry season, there is less water vapor and hence, higher scale height.

Using the monthly mean of the available five year data, the seasonal averages of the level radio refractivity is shown in Table 1. From the table, the dependence of the radio refractivity on moisture content could be easily seen as the wet season has higher radio refractivity than the dry season at all level besides the gradual decrease of radio refractivity as one climbs up from the surface to the upper atmosphere.

Table 1:Seasonal variation of radio refractivity at all levels in Lafia.

Height h(km)	Wet Season Average of N (N-units)	Dry Season Average of N (N-units)
0.0	294.4	282.0
0.1	290.9	278.9
1.5	245.9	235.4
3.1	204.9	200.5
5.6	150.9	147.2
9.3	97.3	97.1
12.0	71.1	71.1

Figure 3 shows the annual variation of the radio refractivity at various atmospheric levels. The lower radio refractivity during the dry season and the higher radio refractivity during the wet season could be easily seen on Figures 3A and 3B, these two figures presents radio refractivity below the scale height of the radio refractivity in Lafia. Above the radio refractivity scale height, as presented in Figures 3C and 3D, the radio refractivity becomes somewhat "erratic", this is as a result of a very small and variable amount of moisture content at these levels.







(D)

Figure 3: Annual variation of the radio refractivity at various atmospheric heights: (A)

surface, 0.1km and 1.5km variation, (B) 3.1km and 5.6km variation, (C) 9.3km

variation, (D) 12.0km variation.

### Refractivity Gradient (G) and the effective earth radius factor k

The level refractivity gradient, as obtained from the Eq. 9 is shown in Eq. 12, it describes refractivity gradient at any height for all seasons in Lafia. Meanwhile, for both the dry and wet seasons, Eqs13 and 14 where obtained. It could be seen from Eqs13 and 14 that the refractivity gradient near the ground surface is greater during the dry season than during the wet season. The annual average refractivity gradient for the first 100m from the surface was found to be ~-33.2 N-units/km, while between 100m and 1.5km the average was found to be  $\sim$ -31.7 *N*-units/km.

G=-33.84exp(-h/8.55)	12
G=-35.23exp(-h/8.40)	13
G=-32.92exp(-h/8.62)	14

From Table 2, it could be seen that the refractivity gradients is generally greater than -40 N-units/km while the effective earth radius factor k could be seen

to be between 1.33 and 0. These two results show that the atmosphere over Lafia, between the surface and 1.5km, usually sub-refract radio waves.

Table 2: Monthly average of refractivity gradient at the first 100m from the surface (G1) and

between 100m and 1.5km (G2) together with the effective earth radius factor k.

Month	Refractivity Gradient G1 from surface to 100m (N-units/km)	k-factor for G1	Refractivity Gradient G2 between 100m and 1.5km (N-units/km)	k-factor for G2
January	-31.8	1.25	-31.0	1.25
February	-32.4	1.26	-31.4	1.25
March	-32.4	1.26	-30.6	1.24
April	-34.2	1.28	-31.1	1.25
May	-35.0	1.29	-31.7	1.25
June	-34.8	1.28	-32.1	1.26
July	-34.8	1.28	-32.5	1.26
August	-35.0	1.29	-33.0	1.27
September	-35.0	1.29	-32.6	1.26
October	-34.6	1.28	-31.9	1.26
November	-33.0	1.27	-31.0	1.25
December	-25.4	1.19	-31.3	1.25

The diurnal variation of radio refractivity as computed from the mean of all days in August (the peak of wet season) and December (dry harmattan month) for the year 2015 is shown in Figure 4. The maximum diurnal value of the radio refractivity for the month of August was found to be ~365.5 N-units (occurring around 2:00Hr, local time) while the maximum diurnal value for December was found to be ~295.0 N-units (occurring around 16:00Hr, local time). The minimum for the month of August was found to be ~346.6 *N*-units (occurring around 16:00Hr, local time) while the minimum for December was found to be ~287.7 *N*-units (occurring around 23:00Hr, local time). The average radio refractivity for the month of August was found to be ~357.3 N-units while December has an average of ~291.3 N-units.



Figure 4: Daily mean of diurnal variation in radio refractivity for the months of August and December, 2015.

Due to the higher water vapor content, the wet season radio refractivity could be seen to be higher than the dry season's radio refractivity. Meanwhile the wet season's radio refractivity could be seen to be higher during the night time than the daytime radio refractivity, this results in bending away of radio waves from the earth's surface as well as considerable fading away of radio waves during the day in Lafia.

The dry harmattan month is an opposite of what happened during the wet season; the radio refractivity generally, is higher during the day than at night due to the generally low temperature during the day, observed during this period, as a result of the harmattan dust blocking the solar radiation from reaching the ground. At night the heat energy, which has been slowly absorbed during the day, is released and again blocked from radiating out thereby increasing the nighttime temperature which in turn reduces moisture and hence, reduces radio refractivity at night.

### CONCLUSION

Using a five year CM SAF ATOVS' satellite data spanning the year 2010 to 2014, a model of the form  $N=289.2\exp(-h/8.55)$  useful for estimating the radio refractivity at any height within the troposphere over Lafia city was derived; similar models useful during dry and wet seasons were also derived.

The radio refractivity at the surface in Lafia were found to be ~294.4 and 282.0 *N*-units for both wet and dry seasons respectively, but these decreases to ~71.1 *N*-units for both seasons at about 12.0 km above the ground surface, meanwhile the radio refractivity scale height in Lafia was found to be about 8.55 km; the wet season scale height was found to be ~8.40 km while the dry season scale height was found to be ~8.62 km.

The refractivity gradient as well as the effective earth radius factor show that within the first 1.5 km of the atmosphere in Lafia city, sub-refraction of radio waves predominates at all seasons.

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### REFERENCES

- Adediji, A. T. and Ajewole, M. O.(2011). Variation of Radio Refractivity Gradient and Effective Earth Radius Factor(k-factor) over Akure, South Western Nigeria.*IEEE*, 978-1-4244-5118-0/11/\$26.00
- Adediji, A. T. and Ajewole, M. O. (2008). Vertical profile of radio refractivity gradient in Akure South-West Nigeria. *Progress in Electromagnetic Research* C. 4, pp157 168.
- Bashir, S.O. (1989). Three years statistics of RefractiveIndex Gradient and Effective Radius factor for the state of Bahrain: *IEE Conference Publications* 301 (ICAP 89), pp220-223.
- Battan, L. J. (1973). Radio observation of theatmosphere. Univ. of Chicago Press, Chicago, pp76-78.
- Grabner, M. and Kvicera, V. (2011). Atmospheric Refraction and Propagation in lower Troposphere,Electromagnetic Waves, Prof.VitaliyZhurbenko (Ed.), ISBN: 978-953-307-304-0, InTech, Available from:http://www.intechopen.com/books/electromagnetic-waves/atmosphericrefraction-and-propagation-in-lowertroposphere.
- Hall, M. P. M. (1979). Effects of the Troposphere on Radio Communications. 14 46,445 IEEE Peter Peregrinus Ltd., London and New York.
- ITU-R (2009). The Refractive Index: Its Formula and Refractivity Data.453-9.
- Manning, T. (1999). Microwave Radio Transmission Guide. *British library cataloguing in the publication data*. pp 89-115.
- Otasowie, P.O. and Edeko, F.O. (2009). An investigation of microwave link degradation due to Atmospheric conditions (A case study of Akure-Owo digital microwave link). *Advances in Materials and System Technologies*, Vol. 62-64, pp 159-165.
- Otasowie, P.O. and Edeko, F.O. (2015).Radio Refractivity Study InAkure-Owo Digital Microwave LinkIn South Western Nigeria. *Nigerian Journal of Technology*, 34(3), pp606 – 608, doi: http://dx.doi. org/10.4314/njt.v34i3.25
- Valma, E., Tamosiunaite, M., Tamosiunas, S., Tamosiuniene, M. and Zilinskas, M. (2010). Determination of radio refractive index using meteorological data Electronics and Electrical Engineering – Kaunas. *Technologija*, 10(106), pp125–128.
- Zilinskas M., Tamosiunaite, M., Tamosiuniene, M., Valma, E. and Tamosiunas, S. (2012). Gradient of Radio Refractivity in Troposphere. Progress in Electromagnetics, 488 *Research Symposium Proceedings*, Moscow, Russia.

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