TERTIARY EDUCATION TRUST FUND

AGRICULTURAL AND BIOLOGICAL SCIENCES

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

[1]*Ilouno, E. L.*, [2]*Ndimele, E. C.*, [3]*Adikwu, O. and* [3]*Obiekezie, S. O.*
[1]*Department of Biochemistry and Molecular Biology, Federal University, Dutsin Ma, Katsina State.*
[2]*College of Health Science, Abia State University, Uturu, Abia State.*
[3]*Department of Biological Sciences, Nasarawa State University, Keffi, Nasarawa State.*

Corresponding Email: drsmartobiekezie@yahoo.com

Date Manuscript Received:20/12/2015 Accepted:30/02/2016 Published: March 2016

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 S*taphylococcus 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 crop-producing 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/non-addition 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 food-borne 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 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 10-1dilution. Further 10-fold 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 $37^{o}C$ 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 $37^{o}C$ 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 ($\times 10^5$ 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) (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%) andhighly 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).

Table 1: Total bacterial, total coliform and total faecal coliform counts of garri, cassava and yam flours sold within Keffi metropolis (×10^5 cfu/g)

Samples	**THBC**	**TCC**	**TFCC**	*S. aureus*	*Salmonella* spp
Garri	3.5	1.6	2.4	2.8	3.2
Cassava	4.8	3.7	4.1	3.6	2.5
Yam	2.9	1.4	2.2	3.1	1.2

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

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

Cultural Shape	PIG Size	M.P	G.S	Biochemical test CAT	IN	V.P	MR	OX	CH utilization CTGluc.	Lact.	Probable isolates
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	-	+	+	-	+ -	-	A	*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 pink on MAC	slightly curved rod	-	+	+	-	+	-	AG	*Escherichia coli*
Circular	4mm	whitish on NA Pinkish on MAC	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	% Occurrence					
		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

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, *Staphylococcu*s 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 × 10^5 cfu/ml, while cassava flour's counts ranged between 2.5–6.2 × 10^5 cfu/ml. Yam flour also had a count ranged of 1.2–4.4 × 10^5 cfu/ml. Ready to eat foods with plate counts of ≤10^3 are acceptable, counts of 10^4 to 10^5 are tolerable while counts ≥10^6 are unacceptable (ICMSF, 1996).

The presence of contaminants to the order of 10^5

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). Ekundayo 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, Inyang, 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 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., Aguilar, 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 Kunun-zaki 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.