Bacteriology quality of traditionally processed peanut butter sold in Port Harcourt metropolis, Rivers State, Nigeria

Odu NN and Okonko IO

Department of Microbiology, University of Port Harcourt, East-West Road, P.M.B. 5323, Choba, Port Harcourt, Rivers State, Nigeria;
mac2finney@yahoo.com; iheanyi.okonko@uniport.edu.ng; Tel: +234-80-3538-0891

ABSTRACT: The assessment of the quality and safety of food is important in human health. This study evaluated the bacteriology quality of traditionally processed peanut butter sold in Port Harcourt metropolis, Rivers State, Nigeria. A total of four samples of processed and packaged (plastic and nylon) peanut butter were purchased from two local markets (Mile 1 and Mile 3 markets) and analyzed for their bacteriological quality. Eighteen isolates belonging to seven genera of bacteria were isolated from the samples. These include *Staphylococcus* sp., *Escherichia coli, Salmonella* sp*., Bacillus* sp., *Serratia* sp., *Proteus* sp. and *Micrococcus* sp. *Staphylococcus sp.* and *Escherichia coli* had equal and highest percentage occurrence of 22.2%. This was followed by *Salmonella* and *Bacillus species* (16.7%), *Serratia sp.* was (11.1%) while *Proteu*s and *Micrococcus species* had the lowest percentage occurrence (5.6%). The total viable counts ranged from 3.5 x 10^2 cfu/g – 2.3 x 10^3 cfu/g. The *Staphylococcus* count ranged from 1.2 x 10^2 cfu/g - 2.1 x 10^3 cfu/g, *Bacillus* count ranged from 1.5 x 10^2cfu/g -2.5 x 10^3 cfu/g and the total coliform count 2.0 x 10^2 cfu/g - 1.75 x 10^3 cfu/g. A total of 12 bacteria isolate were detected from mile1 peanut butter samples (MIN and MIP) and a total of 6 bacteria isolates were also recovered in mile 3 peanut butter samples (M3N and M3P). Whereas, *Bacillus* sp*, Proteus* sp*, Staphylococcus* sp*, Salmonella* sp*, Escherichia coli,* and *Serratia* sp*,* were isolated from MIP samples, *Proteus* sp *and Staphylococcus* sp were not isolated from MIP samples. *Bacillus* sp and *Escherichia coli*, only was isolated from M3N while *Staphylococcus* and *Micrococcus* sp. were isolated from M3P samples. Also, MIP had more gram negative bacteria (GNB) compared to other samples while the numbers of gram positive bacteria (GPB) isolates were equal in the MIP samples. This study showed that the bacteriological quality of traditionally processed peanut butter creates a potential danger with regard to public health. Therefore, there is need for systematic and universally applicable approach to food safety control. The substantial presence of pathogenic bacteria in retailed peanut butter samples indicates the need for appropriate hygienic handling of the product from the raw materials through processing stages to storages and/or retailing and to protect indigenous consumers visitor exposed to consumption of such peanut butter from potential health hazards.

[Odu NN and Okonko IO. **Bacteriology quality of traditionally processed peanut butter sold in Port Harcourt metropolis, Rivers State, Nigeria.** *Researcher* 2012;4(6):15-21]. (ISSN: 1553-9865). http://www.sciencepub.net/researcher. 4

Keywords: Bacteriological quality, *Staphylococcus* sp., *Escherichia coli,* peanut butter, *Salmonella* sp*., Bacillus* sp., *Serratia* sp., *Proteus* sp., *Micrococcus* sp.

1. INTRODUCTION

Peanut (Groundnut) (*Arachis Hypogaea L.*) Occupies an important position in the developing countries, the major groundnut producing countries are India, China and the United States. It was introduced in to Nigeria in the 16th century and it has been estimates that about 1.4 million hectare is cultivated for groundnut in Nigeria. Peanut butter is a food paste made primarily from ground dry roasted peanut (groundnut) and is popular in the Philippines, North America, the Netherlands and the United Kingdom. It is mainly used as a sandwich spread, sometimes in combination (peanut butter and jelly sandwich). Peanut butter has been frequently associated with food illness in which initial contamination is traceable to food handlers. Numerous epidemiological reports and studies have implicated foods of ready to eat origin as the major vehicles associated with illness caused by food- borne pathogens. Person to person transmission has also been described (Sokari, 1991). *Escherichia coli, Staphylococcus aureus, Yesinia enter-colitiia, Salmonella sp, Yeasts* and moulds have been used to assess the microbiological safety and sanitation conditions during processing and keeping quality of peanut butter product (Consumer report, 2009).

In Nigeria, peanut butter is produced traditionally on a small scale and as such has been given little or no attention on the microbiological quality and safety of traditionally processed Nigerian peanut butter is lacking in literature. The aim of the present study was to evaluate the bacteriological quality of Nigerian traditionally

processed and packaged (nylon and plastic) peanut butter sold in Port Harcourt metropolis.

2. MATERIALS AND METHODS

2.1. SOURCE OF SAMPLES

Traditionally processed and packaged (nylon and plastic) samples of peanut butter used for this study were purchased from two local markets (mile 1 and mile 3 markets) in Port Harcourt, Rivers State, Nigeria. Samples were collected and transported in previously alcohol-sterilized food flasks and analyzed within two hours of arrival at the microbiology laboratory of University Port Harcourt, Nigeria.

2.2. MICROBIOLOGICAL ANALYSIS

For the purpose of this study, four forms of samples were use, mile 1 nylon sample (MIN), mile 1 plastic sample (MIP), mile 3 nylon sample (M3N), mile 3 plastic samples (M3P). MIN and M3N are traditionally processed peanut butters, wrapped in nylon and procures at retail points from mile 1 and mile 3 markets respectively whereas, MIP and M3P are peanut butters packaged in plastic containers from the same location respectively.

2.3. SAMPLE PREPARATION

A 25g representative sample was removed aseptically from the samples (MIN, MIP, M3N and M3P) in to a sterile stomacher bag and 225ml 0.1% peptone water (ph 7.0) was added and blended for 2minutes using a stomacher laboratory blender 400 (Seward, London) to obtain a 1:10 dilution. Further 10-fold dilutions were prepared using the same diluents.

2.4. ENUMERATION OF MICROBIAL POPULATION

2.4.1. Total Viable Aerobic Counts

Appropriate dilutions of the homogenate samples (MIN, MIP, M3N and M3P) were made and aerobic plate counts determined using the pour plate method (1.0ml) on nutrient ager (Unipath Ltd, Basingstoke, UK). Plates (in duplicate) were incubated at 37^0C for 24hours. Representative typical colonies from well-isolated plates showing 30-300 colonies (Efiuvwevwere and Amadi, 1992) were picked at random, sub-cultural on selective growth media for purification, stored in slopes at refrigeration temperature and used for morphological and biochemical tests.

2.4.2. Enumeration of Total Coli forms and *Escherichia coli*

Coliform contamination level (CCL) was used as an index of sanitary quality of peanut butter. A liquid media repair method (Speck, 1984) was employed for enumeration of sub-lethally injured coli-forms. Appropriate dilutions of the homogenate samples were inoculated into tubes of lactose broth. The tubes were incubated at 30^0C for 1hour to allow metabolic recovery of the coli-forms; Inoculums from the tubes were then spread-plated onto plates of MacConkey ager in duplicates and incubates at 37^0C for 24hours. For enumeration of *Escherichia coli*, inoculums from tubes of appropriate dilutions were spread-plated onto plates of Eosin Ethylene Blue ager in duplicate (Oxide CM 69) and incubated at 37^0C for 24hours.

2.4.3. Enumeration of *Salmonella* and *Shigella* sp

A liquid media repair method (Speck, 1984) was adopted for stressed Salmonellas and Shigella. Appropriate dilution of the homogenate samples were inculcated into tubes of tetrathionate broth (culture A.), incubated at 42-43^0C for 24hours and tubes of serenity (culture B), incubated at 37^0C for 24hours. After 24hours incubation in tetrathionate broth (culture A) and selenite broth (culture B), samples (0.1ml) of each culture were then spread-plated onto Bismuth sulphite agar plus Brilliant green after 48hours incubation at 37^0C.

2.4.4. Enumeration of *Bacillus* sp

Appropriate dilutions were heat-shocked in water bath at 80^0C for 10minutes, then 0.1ml of the dilutions were spread-plated on Mussel agar (Bacillus cereus selective agar) supplemented with polymyxin-egg Yolk-mannitol-bromothymol blue agar (PEMBA) (Unipath Ltd.). The plates were incubated at 37^0C for 24hours (Speck, 1984).

2.4.5. Enumeration of Staphylococci

A liquid repair method (Speck, 1984) was employed for the enumeration of stressed Staphylococci. Appropriate dilutions were made in nutrient broth and then incubated for 24hours at 37^0C. Aliquots (0. 1ml) of dilutions were spread-plated onto plates of mannitol salt agar in duplicates and incubated for 24-48hours at 37^0C. The plates were examined for Staphylococcus aurous colonies.

2.5. IDENTIFICATION OF BACTERIAL ISOLATES

The morphological tests included Gram-staining and motility while biochemical characteristics of the bacteria isolates were based on in dole, citrate utilization, cataloes, methyl red, coagulate, starch hydrolysis, sugar fermentation Voges Proskauer and production of hydrogen sulphide, following these tests, the isolates were identified.

3. RESULTS ANALYSIS

3.1. BACTERIOLOGICAL QUALITY OF PEANUT BUTTER

A total of four samples of peanut butter from two local markets were analyzed to assess their bacteriological quality. The total viable counts ranged from 3.5 x 10^2 cfu/g – 2.3 x 10^3 cfu/g. The *Staphylococcus* count ranged from 1.2 x 10^2 cfu/g - 2.1 x 10^3 cfu/g, *Bacillus* count ranged from 1.5 x 10^2cfu/g -2.5 x 10^3 cfu/g and the total coliform count 2.0 x 10^2 cfu/g - 1.75 x 10^3 cfu/g (Table 1).

Table 1: Viable count of bacterial isolates from peanut butter

Samples	TVC (cfu/g)	*Staphylococcus* count (cfu/g)	Total coliform count (cfu/g)	*Salmonella-Shigella* count (cfu/g)
MIP	3.5 x 10^2	2.6 x 10^2	2.5 x 10^2	2.75 x 10^2
M3P	3.8 x 10^2	1.2 x 10^2	1.5 x 10^2	2.0 x 10^2
MIN	1.5 x10^3	2.0 x10^3	1.2 x10^3	1.75 x10^3
M3N	2.3 x 10^3	2.1 x 10^3	2.5 x 10^3	1.70 x 10^3

Key: MIN = mile 1 Nylon sample; MIP = mile 1 Plastic sample; M3N= mile 3 Nylon Sample; and M3P = mile 3 Plastic sample

3.2. IDENTIFICATION OF ISOLATES FROM PEANUT BUTTER SAMPLES

On the whole, 18 isolates belonging to seven genera were identified (Table 2). The bacteria genera were *Proteus, Serratia, Micrococcus, Bacillus, Staphylococcus, Salmonella* and *Escherichia* species. A total of 12 bacteria isolate were detected from mile1 peanut butter samples (MIN and MIP) and a total of 6 bacteria isolates were also recovered in mile 3 peanut butter samples (M3N and M3P) (Table 2). Whereas, *Bacillus* sp*, Proteus* sp*, Staphylococcus* sp*, Salmonella* sp*, Escherichia coli,* and *Serratia* sp*,* were isolated from MIP samples, *Proteus* sp *and Staphylococcus* sp were not isolated from MIP samples. *Bacillus* sp and *Escherichia coli*, only was isolated from M3N while *Staphylococcus* and *Micrococcus* sp. were isolated from M3P samples. Also, MIP had more gram negative bacteria (GNB) compared to other samples while the numbers of gram positive bacteria (GPB) isolates were equal in the MIP samples (Table 2).

Table 2: Bacterial isolates from different samples

Isolates	Present or absent in samples			
	M1N	M1P	M3N	M3P
Bacillus sp.	+	+	+	-
Proteus sp.	-	+	-	-
Staphylococcus sp.	-	+	-	+
Micrococcus sp.	-	-	-	+
Serratia sp.	+	+	-	-
Salmonella sp.	+	+	-	-
Escherichia coli	+	+	+	-

Key: MIN = mile 1 Nylon sample; MIP = mile 1 Plastic sample; M3N= mile 3 Nylon Sample; and M3P = mile 3 Plastic sample; + = present; - = absent.

3.3. PERCENTAGE OCCURRENCE OF BACTERIAL ISOLATES

The percentage frequency of occurrence of bacterial isolates is shown in Table 3. Of the seven genera of bacteria identified *Staphylococcus sp*. and *Escherichia coli* had the highest percentage of occurrence (22.2% each). This was followed by *Bacillus sp*. and *Salmonella* sp. which had 16.7% occurrence each. The frequency of occurrence of *Serratia sp.* was 11.1% while *Proteus* and *Micrococccus* species had equal occurrence, 5.6% each. Other details are shown in Table 3.

Table 3: Bacterial isolates from different samples

Isolates	Number (%)				
	Total	M1N	M1P	M3N	M3P
Bacillus sp.	3(16.7)	1(33.3)	1(33.3)	1(33.3)	0(0.0)
Proteus sp.	1(5.6)	0(0.0)	1(100.0)	0(0.0)	0(0.0)
Staphylococcus sp.	4(22.2)	0(0.0)	2(50.0)	0(0.0)	2(50.0)
Micrococcus sp.	1(5.6)	0(0.0)	0(0.0)	0(0.0)	1(100.0)

Serratia sp.	2(11.1)	1(50.0)	1(50.0)	0(0.0)	0(0.0)
Salmonella sp.	3(16.7)	1(33.3)	2(66.7)	0(0.0)	0(0.0)
Escherichia coli	4(22.2)	1(25.0)	1(25.0)	2(50.0)	0(0.0)
Total	**18(100.0)**	**4(22.2)**	**8(44.4)**	**3(16.7)**	**3(16.7)**

Key: MIN = mile 1 Nylon sample; MIP = mile 1 Plastic sample; M3N= mile 3 Nylon Sample; and M3P = mile 3 Plastic sample

4. DISCUSSION

The assessment of the quality and safety of food is important in human health. A high bacteria colony alone dose not make food unsafe but it dose suggest non-hygienic handing, poor storage, inadequate general hygiene during processing and/or poor quality raw materials (Newsome, 1988). The present study evaluated the bacteriological quality of traditionally processed peanut butter at retail points in two local markets (Mile 1 and mile 3). The results revealed that *Staphylococcus* sp; *Salmonella* sp; *Serratia* sp, *Bacillus* sp, *Escherichia* coli and *Micrococcus* sp, were isolated from mile 1 peanut butter samples and *Micrococcus* sp, S*taphylococcus* sp, *Escherichia coli* and *Bacillus* sp, were also isolated from mile 3 peanut butter samples. The prevalence and degree of occurrence of one or two of these organisms over others are dependent on the environment (Okonko et al., 2009a,b). The presence of these organisms was also reported in a previous study on ready-to-eat seafood and palms of food handlers by Okonko et al. (2008a,b, c, 2009a,b) and Adebayo-Tayo et al. (2012a).

The presence of *Escherichia coli*, *Proteus* sp, and *Salmonella* sp in peanut butter samples indicates the possibility of a microbial hazard and fecal contamination. Coliforms are considered as normal flora of the intestinal tract of humans and animals. They have been used as indictor organisms for bacteriological quality of food and water. *Escherichia coli* and *Salmonella* sp have been used to assess microbiological safety, sanitization condition during processing and keeping quality of ready-to-eat food (Owhe-Ureghe et al., 2003). The isolation of these organisms in peanut butter is in line with the findings of Adesiyun and Balbrishing (1996); these workers reported that *Escherichia coli* and *Salmonella* sp are among the most important food borne bacteria pathogens in ready to eat food. In the pathogenesis of salmonella infection, it is known that the main route of entry into the host is the mouth (Sokari, 1991). *Escherichia coli* cause dysentery (Nester et al., 1995; Adebayo-Tayo et al., 2012c).

The presence of the most frequently isolated index of food and water quality and indicators of faecal contamination such as *E. coli* reported in this study is an indication of faecal contamination of the peanuts butter samples used for this study and unhygienic handling of the products right from the source or contamination of the fishes itself during harvesting, handling and storage and this might have adverse effect on the health of the consumers (Okonko et al., 2008a,b,c, 2009a,b; Adebayo-Tayo et al., 2012a). Selected strains can cause a wide variety of infections in hospitals and community setting (Donnenberg, 2005; Adebayo-Tayo et al., 2012a). *Escherichia coli* is commonly used as surrogate indicator, its presence in food generally indicate direct and indirect fecal contamination (Clarence et al., 2009; Adebayo-Tayo et al., 2012a). Bacterial gastrointestinal infections continue to cause illness and death and contribute to economic loss in most parts of the world, including high-income countries that have developed surveillance and control programs (Ternhag et al., 2008; Adebayo-Tayo et al., 2012a).

Bacillus which is known to be one of the highest occurring bacterial isolate causes toxin-medicated disease rather than an infection (Adebayo-Tayo et al., 2012b). *Bacillus* sp, is a normal inhabitant of the soil and a poisoning organism associated with animals. This is however, because of the survival advantage which the spores have in air and in other harsh condition. Contamination could be from the water and materials used in processing the peanut butter traditionally. The enterotoxins produced by this organism are stable at pH 8-10. Sokari (1991) reported the isolation of *Bacillus* sp, in ready-eat-food in Nigeria. This organism is capable of surviving very harsh conditions including roasting temperature to which the peanut were subjected during processing. Spore-forming bacteria are usually associated with spoilage of heat-treated foods because their spores can survive high processing temperatures (Doyle, 2007; Adebayo-Tayo et al., 2012b). These Gram-positive bacteria may be strict anaerobes or facultative (capable of growth with or without oxygen) (Doyle, 2007). Other thermophiles (*Bacillus* and *Geobacillus* spp.) cause a flat sour spoilage of high or low pH canned foods with little or no gas production, and one species causes ropiness in bread held at high ambient temperatures (Pepe et al., 2003; Doyle, 2007; Adebayo-Tayo et al., 2012b). Mesophilic anaerobes (*Bacillus* spp.), growing at ambient temperatures, cause several types of spoilage of vegetables (Chang and Kang, 2004; Doyle, 2007). Psychrotolerant spore-formers produce gas and

sickly odors in chilled meats and brine-cured hams (*Clostridium* spp.) while others produce off-odors and gas in vacuum-packed, chilled foods and milk (*Bacillus* spp.) (Doyle, 2007; Adebayo-Tayo et al., 2012b).

The occurrence of *Staphylococcus aureus* in peanut butter samples may be a reflection of repeated hand contact with these foods at the point of sale. In addition, temperatures of 26-38^{0}C are often encountered in the retail points from which the samples were purchased, hence, growth of this organism may have been favoured. Outbreaks of staphylococcal food poisoning have been reported to occur as the result of contamination of precooked food, often through unsanitary handing and holding food at temperatures that allow the growth and toxin production (Newsome, 1988, Neihart et al., 1988; Synder and Poland, 1991). The observed high percentage of occurrence of *Staphylococcus sp*. in the peanut butter samples may be attributed partly to post-processing contamination from the variety of customers who patronize these retailers (Noble et al., 1987). Additionally, this may result from the washing of cookery, grinding machines and other utensils. The sanitary conditions of the environment of these markets may also lead to contamination of food and food products. The presence of these microbes is an indication of possible contamination resulting from the use of well water, which is mostly used in local food processing industries are not free from microbial contamination (Potter, 1983; Adebayo-Tayo et al., 2009, 2012c). *S. aureus* known for production of heat stable enterotoxin (Stewart, 1974) and potentials for multiple antibiotic resistances when they get into the living tissue (Foster, 1996; Allen and Cowan, 1997; Okuma et al., 2002; Scott, 2002; Klein et al., 2007; Adebayo-Tayo et al., 2012c) makes the product of immense epidemiological danger (Adebayo-Tayo et al., 2009, 2012c).

The microbial contamination of ready-eat foods could be closely related to the method of preparation and handing. As would be expected, heat-stressed microorganisms that survived roasting was probably capable of growing if sample were not conserved under appropriate temperature conditions (Sokari, 1991: Devriese et al., 1986). International microbiological standards recommend limits of bacterial contamination in the range of 10-10^2 cfu/g for total aerobic plate count (ICMSF, 1986). Since large numbers, typically > 10^6 cfu/g, are required for the production of enough toxins to cause illness, contamination is necessary but is not alone sufficient for an out break to occur (Adams and Moss, 1999). Hood et al. (1983) found that fecal coliform levels were above the recommended wholesale level suggested by the National Shellfish Sanitation Program (less than or equal to 230/100 g). This is in agreement with earlier report by Agbu et al. (1998) in Kastina in terms of high viable counts of coliform density in the water ecosystem. In particular, holding the product for sale at temperature and time that allow the organism to grow to hazardous levels could be risky. It is an acknowledged fact that unsold samples are usually presented for sale the next day perhaps with gentle heat treatment. Such unwholesome practices could result in higher levels of toxins due to build-up on subsequent days. *Staphylococcus aureus* strains demonstrate elevated thermal resistance, which precludes inactivation by current culinary heating techniques (Synder and Poland, 1991: Acco et al., 2003).

The isolation of *Salmonella* spp. and *S. aureus* in this study is of practical impact. It shows that most of the seafood products might have been contaminated from source (Adebayo-Tayo et al., 2012a). It is an evidence of poor sanitary conditions. *E. coli* and *S. aureus* are normal flora in human and animals, their presence in foods are indications of excessive human handling (Clarence et al., 2009; Adebayo-Tayo et al., 2012a). *Escherichia coli* is implicated in newborn meningitis and infantile diarrhea, *Salmonella paratyphi* is the causative agent of paratyphoid fever in humans, who are the only reservoir of this organism (Nester et al., 1995; Adebayo-Tayo et al., 2006, 2012c). *Enterococcus* sp. has been implicated in human infections like pharyngities, scarlet fever and pneumonia (Adebayo-Tayo et al., 2009, 2012c). Whatever the cause of contamination, appropriate control measures should be applied from the raw materials through processing to packaging and/ or storage, this will certainly reduce contamination to a very safe level. Attractive packaging and hygienic display of processed peanut butter in protected cabinets in the markets will also minimize potential hazards.

5. CONCLUSION

This study result that the bacteriological quality of traditionally processed peanut butter creates a potential danger with regard to public health. Therefore, there is need for systematic and universally applicable approach to food safety control. The isolation of organisms like *Staphylococcus* sp, *Escherichia coli*, *Bacillus* sp, and *Salmonella* sp, which are of public health significance in traditionally processed peanut butter sample do not only pose health hazards to indigenous consumers but also to visitors exposed to consumption of such enforcing proper sanitation and monitoring of products by relevant regulatory bodies. Education of the local producers by regulatory bodies such as NAFDAC on the use of the hazard analysis critical point (HACCP) concept and quantities risk assessment (QRA) from the raw

material through processing stages to storage and /or retailing is advocated in view of possible microbial hazards in traditionally processed peanut butter.

Acknowledgements

We acknowledge the permission and assistance of the Management and staff of Department of Microbiology, University of Port Harcourt, University of Port Harcourt, Nigeria. The authors sincerely appreciate the assistance and participation of Mr. Anietie Israel Eduo, of Microbiology Technology Unit, School of Science Laboratory Technology, University of Port Harcourt, Nigeria, who assisted in the collection of these samples and analysis.

Correspondence to:
Iheanyi O. Okonko
Department of Microbiology,
University of Port Harcourt, Choba,
PMB 5323 Port Harcourt, Rivers State, Nigeria;
E-mail: mac2finney@yahoo.com;
iheanyi.okonko@uniport.edu.ng
Tel.: +234 803 538 0891

REFERENCES

1. Aoco, M, Ferreira, F. S. Henriques, J. A. P, and Tondo, B. C. (2003), Identification of multiple strains of *Staphylococcus aureus* colonizing nasal mucosa of food handlers. *Food Microbiol,* 20 489-493.
2. Adams, M. R. and Moss, M. O. (1999), Food Microbiology, Royal Society of Chemistry, Cambridge, UK. Pp: 398.
3. Adebayo-Tayo AC; Odu NN; Michael MU;Okonko IO. 2012a. Multi-Drug Resistant (MDR) Organisms isolated from Sea-foods in Uyo, South-Southern Nigeria. *Nature and Science; 10(3): 61-70.*
4. Adebayo-Tayo BC, Odu NN, Igiwiloh NJPN, Okonko IO. 2012b. Microbiological and Physicochemical Level of Fresh Catfish (*Arius hendelotic)* From Different Markets in Akwa Ibom State, Nigeria. *New York Science Journal, 5(4):46-52.*
5. Adebayo-Tayo BC, Odu NN, Okonko IO. 2012c. Microbiological and physiochemical changes and its correlation with quality indices of tilapia fish (*Oreochromis niloticus*) sold in Itu and Uyo markets in Akwa Ibom State, Nigeria. *New York Science Journal, (4):38-45.*
6. Adebayo-Tayo BC, Adegoke AA and Akinjogunla OJ. 2009. Microbial and physico-chemical quality of powdered soymilk samples in Akwa Ibom, South Southern Nigeria. African Journal of Biotechnology, 8 (13): pp. 3066-3071.
7. Adebayo-Tayo BC, Onllude AA, Ogunjobi AA. 2006. Bacteriological and Proximate Analysis of Periwinkle from two different creeks in Nigeria. *World Applied Science Journal 1* (2) 87-91.
8. Adesiyun, A.A and Balbirshningh, V. (1996). Microbiological analysis of black pudding, a rinidadian delicacy and health risk to consumers *Int. J. Food Microbiol*. 31:283-299.
9. Agbu, A.A., Alariba, H.C., Singh, K., and Adesiyun, A.A. (1998) Bacteriological studies and chemical analysis of public well water in Samaru and Zaria city in Northern Nigeria. Journal of Microbiology, 8 (1-2): 88-98.
10. Allen JL, Cowan ME (1997). Monitoring outbreaks of methicillinresistance *Staphylococcus aureus*. Use of a commercial database and personal computer B.J. Biomed. Sci. 54: 10-12.
11. Chang SS and Kang DH. 2004. *Alicyclobacillus* spp. in the fruit juice industry: history, characteristics, and current isolation/detection procedures. Crit Rev Microbiol 30:55–74.
12. Clarence SY, Obinna CN, Shalom NC. Assessment of bacteriological quality of ready to eat food (Meat pie) in Benin City metropolis, Nigeria. Afr. J. Microb. Res., 2009; 3(6): 390-395.
13. Consumer Reports (2009). Peanu Problems in a Nutshell http:blogs.consumerreports.org/health/html.
14. Doyle EM. 2007. FRI BRIEFINGS: Microbial Food Spoilage: Losses and Control Strategies. *A Brief Review of the Literature.* Food Research Institute, University of Wisconsin–Madison http://fri.wisc.edu/docs/pdf/FRI_Brief_Microbial_Food_Spoilage_7_07.pdf.
15. Devriese, L.A., Scheifer, K.H. and Adegoke, G.O. (1985) Identification, of Coagulase negative staphylococci from farm animals. *J. Applied. Bacteri*l., 49:1-11.
16. Donnenberg MS, Mandel GL, Bennett, JE John R, Mandel D. Enterobacteriaeace principles and practice of infectious Diseases 6th edition Elsevier Churchill Livingstone Publishers, Philadephia, 2005; pp. 267-286.
17. Efiuvwevwere, B.J.O. and Amadi, L.O. (1992). Microbiological Characteristics and Deteriorative Changes of 'Kwoka' (a Nigerian Non-Fermented Maize Dish) Produced Using Potassium Sorbate and Various Steaming Treatments. *Journal of the Science of Food and Agriculture.* 60:443-450.

18. Foster T (1996). Staphylococcus. In: Barron's Medical Microbiology, 4th ed., University of Texas Medical Branch. ISBN 0-9631172-1-1.
19. Hood MA, Ness GE, Blake NJ (1983). Relationship among fecal coliforms, *Escherichia coli* and *Salmonella* spp. in shellfish. Appl. Environ. Microbiol. 45(1): 122-6.
20. International Commission on Microbiological Specifications for Foods (ICMSF, 1986). Microorganisms in Food Sampling for Microbiological Analysis: Principles and Specific Applications. 2nd Fda., Vol. 2, Blackwell Scientific Publications, Oxford, pp:293.
21. Klein E, Smith DL, Laxminarayan R (2007). Hospitalizations and Deaths Caused by Methicillin-Resistant *Staphylococcus aureus* in United States, 1999–2005. Emerg. Infect Dis. 13(12): 1840-1846.
22. Neihart, R.E., Freid J.S and Hodges, G.R. (1988). Coagulase-positive staphylococci. *South Med*. J., 81:491-500.
23. Nester, E.W., C.E. Roberts and M.T. Nester, 1995. Microbiology, A Human perspective WM.C Brown publishers. Oxford, England.
24. Newsome, R.I., (1988). *Stapphylococci aureus*. *Food Technol*. 42:194-198.
25. Noble, W.C., Valkenburg, 1-1.A. and Wolters, C.L. (1987). Carriage of staphylococcus aureus in random samples of a normal population *J. Hyg*. 65:567-573.
26. Okonko IO, Ogunjobi AA, Fajobi EA, Onoja BA, Babalola ET, Adedeji AO. Comparative studies and microbial risk assessment of different Ready-to-Eat (RTE) frozen sea-foods processed in Ijora-olopa, Lagos State, Nigeria. African J. Biotech., 2008a; 7(16): 2898-2901.
27. Okonko IO, Ogunjobi AA, Adejoye OD, Ogunnusi TA, Olasogba MC. Comparative studies and Microbial risk assessment of different water samples used for processing frozen sea-foods in Ijoraolopa, Lagos State, Nigeria. African J. Biotechnolo., 2008b; 7(16): 2902-2907.
28. Okonko IO, TA Ogunnusi TA, Ogunjobi AA, Adedeji AO, Adejoye OD, Babalola ET, Ogun AA. Microbial studies on frozen shrimps processed in Ibadan and Lagos, Nigeria. *Scientific Research and Essay,* 2008c; *3(11): 537-546.*
29. Okonko IO, Ogun AA, Adejoye OD, Ogunjobi AA, Nkang AO, Adebayo-Tayo BC. Hazards analysis critical control points (HACCP) and Microbiology qualities of Sea-foods as affected by Handler's Hygiene in Ibadan and Lagos, Nigeria. *African Journal of Food Science,* 2009a; *3(1):035-050.*
30. Okonko IO, Donbraye E, Babatunde SOI. Microbiological Quality of Seafood processors and water used in two different sea processing plants in Nigeria EJEAFche, 2009b; 8(8): 621-629.
31. Okuma K, Iwakawa K, Turnidge J (2002). Dissemination of new methicillin-resistant *Staphylococcus aureus* clones in the community. J. Clin. Microbiol. 40(11): 4289-4294.
32. Owhe-Ureghe, U. B., Ekundayo, A.O. Agbonlahor, D.E. Oboh, P.A. and Orhue, P. (1993). Bacteriological examination of some ready-to-eat foods marketed in Ekpoma, Edo State of Nigeria. *Nig. Food J.* 11:45-52.
33. Pepe O, Blaiotta G, Moschetti G, Greco T, and Villani F. 2003. Rope-producing strains of *Bacillus* spp. from wheat bread and strategy for their control by lactic acid bacteria. Appl Environ Microbiol 69:2321–2329.
34. Potter NN (1983). Food science. 3rd ed. AVI Publishing company incorporated, Westport.
35. Scott K (2002). Epidermiological and Microbiological Characterization of Infection causes by *Staphylococcus aureus* with Reduced Susceptibility to Vancomycin, United State, p. 1997.
36. Sokari, T., (1991). Distribution of enterotoxigenic *Staphylococcus aureus* in ready-to-eat foods in Eastern Nigeria. *Int. J. Food Microbiol.,* 12:275-280.
37. Speck M.E., (1984). Compendium of methods for the Microbiological Examination of Foods. 2nd Edn., American Public Health Association, Washington, DC.
38. Stewart FS (1974). Bigger's Bacteriology and Immunology for students of medicine 9th edn. ELBS and Bailliere, Tindal and Casell.
39. Synder, O.P. and D.M. Poland, (1991). American safe food, 2: Dairy. *Food and Envt. Sanit. 11:14-20.*
40. Ternhag A, Törner A, Svensson Å, Ekdahl K, Giesecke J. Short- and long-term effects of bacterial gastrointestinal infections. Emerging Infectious Diseases, 2008 January [*cited* 2009 August 18]. Available from http://www.cdc.gov/EID/content/14/1/143.htm.

5/24/2012