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MICROBIAL ASSESSMENT OF FURA-NUNU SOLD IN EIYENKORIN, KWARA STATE, NIGERIA

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ABSTRACT

Food-borne diseases are the global public health problems encountered as a result of consumption of contaminated foods. To this end, this study was designed to evaluate the microbial quality of fura-nunu sold in Eiyenkorin, Kwara State, Nigeria. Samples of fura-nunu were collected at different locations within Eiyenkorin and were transported to laboratory for analyses. Microbiological analyses were performed using standard methods. Data obtained from microbial counts were subjected to analysis of variance (ANOVA). Results of total heterotrophic bacteria count (THBC), total coliform count (TCC) and total fungal count (TFC) of fura-nunu indicated that THBC ranged from 1.6 ± 0.03 × 10^7 - 2.3 ± 0.01 × 10^7cfu/ml, TCC ranged from 2.5 ± 0.71 - 15.0 ± 1.41 cfu/100ml while TFC was between 4.0 ± 0.41 × 10^6 and 5.0 ± 5.58 ×10^7 cfu/g. There were significant differences (P<0.05) in THBC, TCC and TFC of fura-nunu samples. pH values ranged from 4.25 ± 0.31 – 5.30 ± 0.21. The identified bacteria with percentage occurrence (%) include; *Lactobacillus* spp. (14.81%), *Staphylococcus aureus* (12.96%), *Escherichia coli* (17.59%), *Bacillus subtilis* (6.48%), *Pseudomonas aeruginosa* (3.70%), *Enterococcus* spp. (8.33%), *Micrococcus* spp. (6.48%), *Salmonella* spp. (13.88%), *Klebsiella* spp. (4.62%) and *Lactobacillus plantarium* (11.11%). Fungi species and prevalence (%) were *Aspergillus flavus* (21.21%), *Aspergillus niger* (30.30%), *Saccharomyces cerevisiae* (16.66%), *Penicillium* spp. (12.12%) and *Mucor* spp. (19.69%). Results of handling and hygienic practices showed poor handling, storage and hygienic practices by fura-nunu vendors. Hence, there is need for proper education of the vendors on general food safety practices.

Contribution/Originality: This study showed the microbial load, probable identity of microorganisms associated in fura-nunu samples sold in Eiyenkorin, Kwara State, the percentage occurrence of microorganisms as well as handling, storage and hygienic practices of vendors and vending environment were fura-nunu are sold.

1. INTRODUCTION

Over the years consumption of locally made food has been on the increase. This is due to the nutritional and some health benefits associated with locally processed foods. Anyanwu [1] reported that locally made food drinks provide an excellent alternative to the conventional food drinks. Fura-nunu, a locally processed food in Nigeria is a two in one nutritious milk beverage consisting of a cereal component called "fura" that is made from millet, and

"nunu" component, a locally fermented milk product similar to yoghurt [1]. In Nigeria, nunu is produced mainly by the nomadic 'Fulani' herdsmen who control over 80% of the cattle population [2]. Nunu is one of the indigenous milk products in Nigeria obtained from fermentation of cow milk [3].

However, Eluchie, et al. [4] defined milk as an opaque white liquid produce or secreted by the mammary glands of female mammals and as such milk provides the primary source of nutrition for new born before they are able to digest other types of food. Abdulhadi and Shamsuddeen [5] opined that milk is sterile at secretion in the udder but is contaminated by bacteria even before it leaves the udder except in the case of mastitis. In addition, milk has a complex biochemical composition and its high water activity and nutritional value serves as an excellent medium for growth and multiplication of many kinds of microorganisms under suitable conditions [1, 6]. A major determinant factor of milk quality has been attributed to its microbial load. Abdulhadi and Shamsuddeen [5] reported that microbial load of milk indicates the hygienic level exercised during milking, transportation and storage of the milk among other factors. Preparation of fura-nunu in Nigeria is a traditional process passed on from one generation to another [7]. It involves grinding of grains (millet), blending of fura with milk and other ingredients. This process typically employs traditionally available utensils such as calabash, mortar and pestle under limited hygiene practice or no hygiene precautions at all [7]. In addition, the fermentation process is usually carried out under uncontrolled environmental conditions and consequently leading to production of metabolites and variations in product quality. Abdulkadir and Mugadi [8] reported that poor handling of fura-nunu during preparation exposes it to microbial contamination. This is because fura is usually molded into balls by hand during its production, and the hands of the producers could be a source of contaminations to the product. Elijah, et al. [9] reported that food prepared locally for human consumption is at greater risk of contamination because foods are normally contaminated with bacteria and other microbes since the environment in which we live is colonized by them. Over the years, incidence of foodborne diseases has been reported. Thus, Elijah, et al. [9] defined food borne diseases as diseases resulting from the ingestion of bacteria, toxins and cells produced by microorganisms present in food. It is capable of reducing the productivity and economic output, and also imposes substantial stress on healthcare system. Eiyenkorin, being the host community of Crown-Hill University is a fast growing populated city in Kwara State, Nigeria. It is located at an elevation of 307 meters above sea level and its population amounts to over 180,000. Its coordinates are 8°24'0" N and 4°28'0" E. To the best of our knowledge, studies on microbial assessment of fura-nunu sold in Eiyenkorin has received little or no attention from the government and food agencies, hence the need to assess the microbial quality of the food in this community with the view of creating public awareness as well as guiding the activities of the vendors. Again, findings from this study will be useful for both government and food processors with the view of protecting consumers from food related illnesses.

2. MATERIALS AND METHODS

2.1. Sample Collection

The fura-nunu (5 samples) was randomly collected from different vendors at different locations in Eiyenkorin, Kwara State, Nigeria and labeled as follows: Sample A (Fura-nunu collected from Ballah road junction), sample B (Fura-nunu obtained near Eiyenkorin Market), sample C (Fura-nunu obtained around Eiyenkorin roundabout), sample D (Fura-nunu obtained along Lagos-Ibadan Express road) and sample E (Fura-nunu obtained along Gambari road). The samples were collected using a clean plastic container stored in a cooler with ice blocks and taken to the laboratory for microbial analysis.

2.2. Bacterial Analysis

One ml each from 10 % dilution was taken and spread on surface of nutrient agar and using a sterile L-shaped glass rod and the plates were incubated at 37°C for 24 hours. After incubation, colonies were observed, counted and recorded. The values were expressed as colony forming unit per ml (cfu/ml) of the sample analyzed. The isolated

colonies were purified by sub-culturing on fresh nutrient agar plate. After the purification, the isolates were maintained on a nutrient agar slant, and kept in the refrigerator at 4°C for identification.

2.3. Characterization and Identification of Bacterial Isolates

Bacterial isolates were characterized based on microscopic appearance (shape, gram's reaction), biochemical tests and the isolates were identified by comparing their characteristics according to the methods described by Harrigan and McCane [10]; Chessbrough [11]; Barnett and Hunter [12] and Holt, et al. [13].

2.3.1. Grams Staining

A smear of the isolate was prepared on a clean, grease free slide. The smear was heat fixed then stained with crystal violet (primary dye) for 60 seconds. After 60 seconds, it was rinsed with water and drained off to remove excess water in order not to dilute the mordant. It was then flooded with iodine for 60 seconds. The slide was rinsed and then decolorized with 95 % alcohol for 30 seconds. It was washed again and then the smear was counter stained with safranin for 60 seconds, rinsed and allowed to dry. The smear was then examined under the oil immersion lens of the microscope (i.e ×100) objective lens.

2.4. Biochemical Tests

2.4.1. Catalase Test

A drop of 3% hydrogen peroxide was placed on clean glass slide. A sterile wire loop was used to pick the isolate and was emulsified on the hydrogen peroxide drop. Observation of bubbling and frothing indicates a positive result and absent of bubbling indicated negative result.

2.4.2. Coagulase Test

A drop of blood serum was placed on clean glass slide. A sterile wire loop was used to pick the isolate and was emulsified on the serum drop. Observation of agglutination indicated a positive result.

2.4.3. Citrate Utilization Test

A 10 ml of Citrate medium was dispensed into test tube and sterilized by autoclaving at 121°C for 15 minutes. The test organism was inoculated into the medium and incubated at 37 °C for 48 hours. A deep blue colouration indicates positive reaction.

2.4.4. Indole Test

The test organism was inoculated in 5 ml of peptone water in a test tube and incubated at 37 °C for 24 hours to give optimum accumulation of indole. About 0.5ml of kovac's reagent was added and if a red colouration was observed at the uppermost layer, this indicates a positive test while a yellow colouration indicated negative test.

2.4.5. Methyl Red Test

The test organism was inoculated into test tube containing MR-VP broth and incubated for 48 hours at 37°C. Three (3) drops of methyl red was added. A red colouration on the addition of the indicator indicates positive methyl red test.

2.4.6. Voges-Proskauer (VP) Test

The isolate was inoculated into test tube containing broth and incubated at 37°C for 48 hours, and 5 drops of 40% KOH was added and followed by 2-5 drops of alphanaptol solution shaken, losing the cap of the test tube and

placed in a sloping position for about 2-5 min. The production of pink colouration in the medium shows a positive reaction.

2.4.7. Urease Test

The isolate was inoculated on a medium containing urea and phenol red indicator and were incubated at 37°C for 24 hours. The development of bright pink or pinkish red colour indicated the positive test.

2.4.8. Gas Formation Test

The organism was stabbed 2 cm depth on a slant test tube containing TSI medium down to the butt. It was incubated at 37°C for 24 hours. Gas production was detected by several gas bubbles in the bottom or cracks on the medium.

2.4.9. Hydrogen Sulfide Formation Test (H_2S)

The test organism was stabbed 2cm deep down on a slant of TSI (Triple Sugar Ion) medium to the butt. It was incubated at 37°C for 24hours. The H_2S formation was determined by black colouration on the streaked line.

2.4.10. Sugar Fermentation Test

The isolate was stabbed 2cm deep down to the button of a TSI medium slant test tube and incubated at 37 °C for 24 hours. After the incubation period, the fermentation of the three sugars in the TSI medium viz: glucose, lactose and sucrose was observed. A changed from red to yellow and the slant remains red, indicated that only glucose was fermented. If all the three sugars (glucose, lactose and sucrose) were fermented both the slant and the butt changed to yellow, thereby indicating a positive reaction for the three sugars.

2.4.11. Motility Test

The test organism was stabbed 2cm deep down to the slant of TSI medium in a test tube. It was then incubated at 37°C for 24 hours. After the incubation, motility will be indicated by the line of inoculation being not sharply defined and the rest of medium being cloudy. The non-motile organism was observed by restricted growth only on a sharply defined line of inoculation.

2.5. pH Determination

The pH was determined following the method reported by Edem, et al. [14]. About 100 ml of sample was poured into a beaker and thoroughly mixed. pH was measured using a pH meter.

2.6. Survey of Handling, Storage and Hygienic Practices of Fura Nunu Vendors

Questionnaires topics on different aspects of food safety, handling and hygienic practices were given to vendors according to the methods of Elijah, et al. [9] and Edem, et al. [15].

2.7. Statistical Analysis

Experimental data obtained from microbial counts were subjected to analysis of variance (ANOVA) and means separated using Duncan's multiple range test of the IBM SPSS software version 20. Significant differences were expressed at 5% level of probability.

3. RESULTS AND DISCUSSION

3.1. Microbial Counts of Fura-Nunu

Table 1 shows the results of total heterotrophic bacteria count (THBC), total coliform count (TCC) and total fungal count (TFC) of fura-nunu sold in Eiyenkorin. THBC ranged from $1.6 \pm 0.03 \times 10^7$ - $2.3 \pm 0.01 \times 10^7$cfu/ml, TCC ranged from 2.5 ± 0.71cfu/100ml while TFC was between $4.0 \pm 1.41 \times 10^6$ and $5.0 \pm 5.58 \times 10^7$ cfu/g. Results in Table 1 showed significance ($P<0.05$) differences in THBC, TCC and TFC of fura-nunu samples under study. The highest THBC count was obtained in sample D which was significantly different ($P<0.05$) from all other samples. However, there was no significant difference in samples B and C. Result also indicated that there was no significant difference in samples A and C with respect to TTC but were significantly different from other samples. TFC showed significant differences in all the samples.

The results obtained were out of standard since the microbial limit for the total viable colony count is 1.0×10^2 cfu/ml [4] and *Escherichia coli* should not be present at all in samples. The microbial loads obtained in this study are higher than the values of $Log_{10}9.614$ -log_{10} 9.689 reported by Ezenweani, et al. [3] but lower than range of values (3.8×10^7 cfu/ml - 7.1×10^7 cfu/ml) reported by Eluchie, et al. [4]. The microbial counts in this study are equally different from the range of values (8.3×10^5 cfu/ml - 1.25×10^8 cfu/ml) reported by Yusuf, et al. [7] and $Log_{10}4.30$ -log_{10} 8.90 cfu/ml reported by Okonkwo [16]. The variation obtained from these microbial counts could be as a result of uncontrolled fermentation procedure during the preparation of fura-nunu. It could also be that the high microbial load may be attributed to poor handling and hygienic practices. The major microbiological hazard is the presence of high microbial population in the products [5]. An important factor which significantly contributes to the great increase in the count is the location of the retail outlet which is basically where the food can be easily contaminated by bacteria carried by air or dust, and several other insects such as flies. Elijah, et al. [9] reported that dust potentially carries pathogens and therefore may become a vector for their transmission to prepared foods. The microbial load in this study is above the standard hence, the product is not suitable for human consumption.

In addition, Table one also showed the pH of the fura-nunu samples, which ranged from 4.25 – 5.30. Results indicated no significant difference ($P>0.05$) in pH of the samples evaluated. The pH values obtained in this study are within the range of values (3.80 - 5.40) reported by Okonkwo [16] on studies on nunu samples in northern Nigeria but lower than the value of 6.8 reported by Yusuf, et al. [7] in Fura-nunu samples produced in Kebbi State, Nigeria. On the other hand, Omola, et al. [2] reported pH range of 4.22 – 4.70. The differences in pH values could be attributed to fermentation conditions such as time and temperature among others. Increased fermentation time will result in a drop in pH.

Table 1. Total heterotrophic bacteria (THBC), total coliform (TCC), total fungal counts (TFC) and pH of Fura-nunu sold in Eiyenkorin.

Samples	Dilutions Factor	THBC (CFU/ml)	TCC (CFU/100 ml)	TFC (CFU/g)	pH
A	10^6	$1.8^{cd} \pm 0.03 \times 10^7$	$6.0^{a} \pm 1.41$	$8.0^{d} \pm 1.41 \times 10^6$	$4.25^{a} \pm 0.31$
B	10^6	$2.0^{b} \pm 0.16 \times 10^7$	$2.5^{c} \pm 0.71$	$4.0^{e} \pm 1.41 \times 10^6$	$4.53^{a} \pm 0.10$
C	10^6	$1.9^{bc} \pm 0.13 \times 10^7$	$15.0^{a} \pm 1.41$	$1.9^{b} \pm 0.21 \times 10^7$	$4.90^{a} \pm 0.20$
D	10^6	$2.3^{a} \pm 0.01 \times 10^7$	$4.0^{bc} \pm 1.41$	$1.3^{c} \pm 0.14 \times 10^7$	$5.30^{a} \pm 0.21$
E	10^6	$1.6^{d} \pm 0.03 \times 10^7$	$2.5^{c} \pm 0.71$	$5.0^{a} \pm 5.58 \times 10^7$	$4.72^{a} \pm 0.15$

Note: Values are means ± standard deviation of triplicate determinations. Means in the same column with different superscripts are significantly ($p<0.05$) different; Superscripts (a –e) indicate the order of statistical difference.

3.2. Isolation and Biochemical Identification of Microbial Isolates

The results of isolation and biochemical characterization and identification of bacteria isolated from fura-nunu samples are presented in Table 2. The identified bacteria include; *Lactobacillus* spp., *Staphylococcus aureus*, *Escherichia coli*, *Bacillus subtilis*, *Pseudomonas aeruginosa*, *Enterococcus* spp., *Micrococcus* spp., *Salmonella* spp., *Klebsiella* spp. and *Lactobacillus plantarium*.

Table 2. Colonial morphology/biochemical tests (Bacteria Identification) results.

Morphology/ biochemical tests	Probable Identity of Bacterial Isolates									
	***Lactobacillus* spp.**	***S. aureus***	***B. subtilis***	***E. coli***	***P. aeruginosa***	***Entero-coccus* spp.**	***Micrococcus* spp.**	***Salmonella* spp**	***Klebsiella* spp.**	***Lactobacillus plantarium***
Shape	**Bacilli/ Cocobacilli**	**Cocci**	**Bacilli**	**Bacilli**	**Bacilli**	**Cocci**	**Cocci**	**Rod**	**Rod**	**Coccobacilli**
Cell arrangement	**Pairs/chains**	**Irregular/ Clusters**	**Pairs/ chains**	**Single**	**Single**	**Chains**	**Circular**	**Single**	**Chains**	**Chains**
Pigmentation	-	-	-	-	+	-	+	-	-	+
Gram reaction	+	+	+	-	-	+	+	-	-	+
Motility	+	-	+	+	+	-	-	+	-	-
Endospore	+	-	+	-	-	-	-	-	-	-
Catalase	+	+	+	+	+	+	+	+	+	-
Oxidase	-	-	-	-	+	-	-	-	-	-
Coagulase	-	+	-	-	-	-	-	-	-	-
Indole	-	-	-	-	-	-	-	-	-	-
Citrate	+	+	+	-	+	+	+	+	+	-
MR	-	-	-	+	-	+	-	+	-	-
VP	+	+	+	-	-	-	+	-	+	-
Gelatin	+	+	+	-	-	-	-	-	-	-
Urease	-	+	-	-	+	-	-	-	+	-
TS Glucose	+	+	+	+	-	+	+	+	+	+
Lactose	-	+	-	+	-	+	-	-	+	+
Sucrose	+	+	+	+	-	-	-	-	+	+
Starch	+	-	+	-	-	+	-	-	+	+
H_2S	-	-	-	-	-	-	-	-	-	-
Gas production	-	-	-	+	-	+	-	-	+	-
O_2 relationship	FA	FA	OA	FA	OA	FA	FA	FA	FA	FA
Occurrence (%)	14.81	12.96	6.48	17.59	3.70	8.33	6.48	13.88	4.62	11.11

Note: + = positive, - = negative, FA = facultative anaerobe, OA = obligate anaerobe.

Microorganisms such as *Staphylococcus aureus* and *Escherichia coli* have been isolated previously by Yusuf, et al. [7] and Okonkwo [16] in fura-nunu. More so, some of the identified bacterial organisms obtained in this study also agreed with the findings of Usman and Mustapha [17]; Yakubu, et al. [18]; Oku and Alagoa [19]; Onyinye and Ezenduka [20] and Aliyu, et al. [21] in which these organisms were implicated in contaminating ready-to-eat hawked foods. Similarly, study by Oranusi and Braide [22] documented *Escherichia sp, Staphylococcus sp Bacillus sp; Shigella sp and Salmonella sp* from street vended foods in Nigeria. Madueke, et al. [23] on microbiological analysis of street food along Lokoja-express way, Lokoja, Nigeria reported these bacteria to involve in food colonization.

The result obtained shows that there are presence of pathogenic microorganisms that may be potential source of food borne infection and some related diseases for the consumers of this product in the sampling areas. *S. aureus* isolated are probably due to poor handling by producers using their contaminated bare hands. The presence of *E. coli* in almost all the samples emphasized the importance of production hygiene during the manufacturing process. This also indicates the lower standards of hygiene in the preparation process of fura-nunu. Abdulkadir and Mugadi [8] reported that *Salmonella* is a strict pathogen and has no habitat other than human or animal body; the source of human infection is therefore human or animals (carrier) the organism been excreted in the faeces or urine and transmitted by food or water which is ingested by another subject. Edem, et al. [15] reported that the presence of *salmonella* spp. and *E. coli* at elevated amount is one of the leading causes of food infections and intoxication if ingested by humans.

The presence of *Lactobacillus* spp. and *Lactobacillus plantarium* corroborates the findings of Yusuf, et al. [7]. The presence of *Micrococcus* spp., *Enterococcus* spp. and *Klebsiella* in this study conforms to the findings of Ezenweani, et al. [3]. It also indicates poor handling practices among handlers. Elijah, et al. [9] opined that *Klebsiella* is one of those organisms that cause high drug resistant pneumonia once it gets to the blood stream and lower regions of the lungs. The authors added that *Micrococcus* varians is a causative agent of tooth decay, thus ingesting any food materials that have been proliferated by this organism is capable of causing health related problems to humans. The presence of these pathogenic organisms including *Pseudomonas* specie has also been implicated in the spoilage of beverages and foods Mbachu, et al. [24]. Edem, et al. [14] reported that their presence is of public health significance, due to their ability to cause infections such as food-borne intoxication.

However, the percentage occurrence of bacterial isolates (Table 2) showed that *E. coli* predominated fura-nunu samples with a value of 17.59 %. This was followed by *Salmonella* (13.88 %), *S. aureus* (12.96 %), *L. planetarium* (11.11 %) and *Enterococcus* spp. (8.33 %). *B. subtilis* and *Micrococcus* spp. recorded total occurrence of 6.48 % each while *Klebsiella* spp. and *P. aeruginosa* had 4.62 and 3.70 % respectively.

Furthermore, cultural and morphological characteristics of fungi isolated from fura-nunu samples are presented in Table 3. The identified fungi isolated from fura-nunu sample include: *Aspergillus flavus*, *Aspergillus niger*, *Saccharomyces cerevisiae*, *Penicillium* spp. and *Mucor* spp. (Table 3). The fungi identified in this study support the findings reported by Yusuf, et al. [7] and that of Oku and Alagoa [19]. Isolation of fungi in ready-to-eat foods sold in Nigerian Cities have been reportedly by a number of authors to include Ayanbimpe, et al. [25]; Oranusi and Braide [22]; Odu and Akano [26]; Oranusi, et al. [27]; Egwaikhide, et al. [28]; Dafur, et al. [29]; Oku and Alagoa [19].

The presence of *Aspergillus flavus* in the samples could make it harmful for consumption, because *A. flavus* produces some strains known as aflatoxin which is linked to a number of human health conditions including cancer [7]. Results in Table 3 revealed the percentage occurrence of fungi isolates isolated from fura-nunu samples. The highest occurrence was observed in *A. niger* (30.30%). *A. flavus*, *Mucor* spp. and *Saccharomyces cerevisiae* recorded 21.21, 19.69 and 16.66 % of occurrence respectively. The least fungal occurrence was observed in *Penicillium* spp. (12.12%).

3.3. Handling, Storage and Hygienic Practices of Vendors in Eiyenkorin

The results of survey questionnaire on vendors profile, handling, storage and hygienic practices are presented in Tables 4 - 8. The results of profile of fura-nunu vendors in Eyenkorin (Table 4) shown that 70% were female and 30% were male. This indicates that female predominate fura-nunu business. In addition, 30% of the vendors were in the age range of 15-24 years, 40% in the bracket of 25-34 years, 20 % within the age range of 35-44 years while 1% were in the age range of 45-54 years.

Table 3. Cultural and morphological characteristics of fungi isolated from fura-nunu samples.

Cultural Characteristics	Morphological Characteristics	Probable Identity	Percentage Occurrence (%)
Pale brown roughened mycelium	Pale brown spherical mycelium, globose shape, smooth finely roughened conidia surface	Aspergillus flavus	21.21
Slightly brown mycelium	Slightly brown mycelium, smooth walled surface, glubose shape, very rough irregular conidia surface	Aspergillus niger	30.30
White-cream mycelium	White-cream smooth colonies	Saccharomyces cerevisiae	16.66
Green colony at the center	Green septum mycelium, round neat velvety colony	Penicillium spp.	12.12
Gray mycelium	Gray mycelium, oval to round globose sporangia	Mucor spp.	19.69

Table 4. Profile of fura-nunu vendors in Eiyenkorin (n=10).

Parameters	Frequency	Percentage (%)
General Information		
Gender		
Female	7	70
Male	3	30
Age range		
< 14 years	0	0
15-24 years	3	30
25-34 year	4	40
35-44 years	2	20
45-54 years	1	10
> 55	0	0
Level of Education		
No Formal Education	4	40
Primary School Education	3	30
Secondary School Education	2	20
College completed	1	10
Period in Business		
1-4 years	2	20
5-9 years	5	50
10-14 years	1	10
15-19 year	1	10
>20 years	1	10

Table 4 also revealed that 40% of these vendors had no former education; however, 30% of the vendors had completed primary school education, while 20% and 10% had complete secondary school and college respectively. More so, 20% of the vendors had 1-4 years business experience. About 50% of fura-nunu vendors have been in the business for the period of 5-9 years. Finally, 10% each have been in the business for the period of 10-14 years, 15-19 years and > 20 years.

Table 5 showed the handling, preparation and storage practices of fura-nunu vendors. On a whole 60% of vendors obtained their raw materials from the market while 40% got from farmers, About 50% of the vendors prepared the product the night before the sales day, 40% of the vendors prepared the product in the morning of sales day while only 10% prepared the product during the day. Results (Table 5) also indicated that 60% of the vendors prepared the product at home while 40% prepared on site. The storage and display of fura-nunu shows that only 1% of vendors displayed the product openly in the stall while 90% of vendors displayed the product in either sealed transparent or opaque containers. Results also showed that only 20% of the leftovers are consumed by the vendors and their families while 80% of the leftovers are stored for use the next day.

The care of utensils use in the preparation of fura-nunu are showed in Table 6 which indicated that 40% of fura-nunu are served in cups to consumers while 60% are served in bowl to consumers. On washing of the utensils 40% of vendors washed with cold water and soap while 60% washed using any available water without soap. On the other hand 100% of the fura-nunu served was covered on display. The hygienic status of the serving materials was determined as 40% of the cups and bowls used were hygienic, 20% were less hygienic. However, hygienic status (40%) of the serving cups and bowls could not be determined during the study.

Table 5. Handling, preparation and storage practices of fura-nunu vendors in Eiyenkorin.

Parameter	Frequency	Percentage (%)
Source of raw materials		
From the market	6	60
From vendors farm	0	0
From farmers	4	40
Time of preparation of fura-nunu		
The night before sales day	5	50
Morning of sales day	4	40
During the day	1	10
Where is preparation done		
At home	6	60
On site	4	40
Storage and display of fura-nunu		
Openly in the stalls	1	10
In a wheel barrow	0	0
In a sealed (transparent/opaque) containers	9	90
How are leftovers taken care of?		
Consumed	2	20
Stored for use next day	8	80

Table 6. Care of utensils by Fura nunu vendors in Eiyenkorin Community.

Parameter	Frequency	Percentage (%)
How is fura-nunu presented to consumers		
Polyethene bag	0	0
Cup	4	40
Bowl	6	60
How are utensils washed		
Hot water and soap	0	0
Cold water and soap	4	40
Any water and soap	6	60
Are fura-nunu covered on display?		
Yes	10	100
No	0	0
How hygienic are serving materials		
Hygienic	4	40
Less hygienic	2	20
Cannot tell	4	40

The personal hygiene of the vendors showed (Table 7) that 100% of the vendors in this study did not use apron, 90% of the vendors covered their hairs and only 10% had their hairs uncovered. About 60% of the vendors had clean short nails. Table 7 also showed that 100% of the vendors handled money while serving fura-nunu. Similarly, 100% of the vendors did not wash their hands after handling money which could be a possible source of microbial contamination from the money to the product. Also, 100% of the vendors did not handle fura-nunu in bare hands, they used spoons. Table 7 revealed that 60% of the vendors washed their hands after using the toilet, while 40% did not wash their hands after using the toilet. More so, only 20% of the vendors washed their hands after blowing their nose or scratching their body, while 80% did not observe hand washing practice. About 80% washed using clean water only while only 20% washed using water and soap. Table 7 also indicated that 100% of vendors, neither undergone food safety training nor medical checkup.

Table 7. Personal hygiene of fura-nunu vendors in Eiyenkorin community.

Parameters	Frequency	Percentage (%)
Use of apron while serving		
Full apron used	0	0
Half apron	0	0
No apron used	10	100
Covering of hair		
Yes	9	90
No	1	10
Does operator has clean short nails		
Yes	6	60
No	4	40
Handling of money while serving fura-nunu		
Yes	10	100
No	0	0
Washing of hands after handling money		
Yes	0	0
No	10	10
Do they handle fura-nunu with bare hands		
Yes	0	0
No	10	100
Are hands washed after using the toilet		
Yes	6	60
No	4	40
Are hands washed after blowing nose or scratching the body before handling fura-nunu again?		
Yes	2	20
No	8	80
How are hands washed		
Using clean water	8	80
Using water and soap	2	20
Have they undergone food safety training		
Yes	0	0
No	10	100
Have they gone for medical check-up on regular basis		
Yes	0	0
No	10	100

The results of hygienic status of the vending environment (Table 8) revealed that 40% of the vending stalls were protected from sun, wind and dust, while 60% were not. In addition, 70% of the environments around the stalls were clean, far from waste water, dump site, toilet facilities, while 30% were close to these. Only 20% of the vending environments had access to portable water at the site or close to the site while 80% had none. With respect to availability of adequate hand washing facilities, only 10% of the vending environment had adequate hands washing facilities, while 90% had none. Results also indicated that only 10% of the vending environment had waste

disposal facilities, while 90% had none. Finally, results also indicated that only 10% had daily frequency of waste disposal, 20% of the wastes generated are disposed on weekly basis while 70% of the waste generated are disposed on a monthly basis. Findings from this survey showed vendors poor handling, preparation, storage and lack of knowledge on good manufacturing practices and these are reflected in the quality of fura-nunu samples sold in the community.

Table 8. Hygienic status of the vending environment.

Parameters	Frequency	Percentage (%)
Is vending stall protected from sun, wind and dust		
Yes	4	40
No	6	60
Is the environment around the stall clean		
Yes	7	70
No	3	30
Accessibility to portable water at the site or close to the site		
Yes	2	20
No	8	80
Are adequate hands washing facilities available		
Yes	1	10
No	9	90
Availability of waste disposal facilities		
Yes	1	10
No	9	90
Frequency of waste disposal		
Daily	1	10
Weekly	2	20
Monthly	7	70

4. CONCLUSION

The findings in this research work confirmed the presence of *Lactobacillus spp*, *S. aureus*, *Escherichia coli*, *B. subtilis* and *P. aeruginosa*, *Enterococcus* spp., *Micrococcus* spp., *Salmonella* spp., *Klebsiella* spp., *Lactobacillus plantarium*, *Aspergillus flavus*, *Aspergillus niger*, *Saccharomyces cerevisiae*, *Penicillium* spp. and *Mucor* spp. from samples of fura-nunu sold in Eiyenkorin. This is evidence that hawked foods are contaminated with pathogenic microorganisms. Some of the species isolated and identified in this study are known to be pathogenic and therefore could pose health hazard. This is to the fact that street food vendors lack hygienic practices and also have no or little knowledge about good manufacturing practices when preparing foods, hence, the need for proper sensitization in food handling, preparation, and storage.

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