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The Level of Contamination of Fura Sold in Karu Local Government Area of Nasarawa State of Nigeria

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Abstract **Original Research Article**

Locally prepared *Fura da Nono* was obtained from three different markets each of Masaka, Auta and Nyanya districts all in Karu Local Government Area of Nasarawa State, Nigeria. Bacteriological analysis were conducted on the samples for isolation and identification of pathogenic and spoilage bacteria. Viable colony counts were determined and the result reveals that the colony count ranged from 4.0 x 10^4 to 7.0 x 10^4 cfu/ml. The bacteria isolated were *Lactobacillus*, *Klebsiella*, *Micrococcus*, and *Salmonella species* also, *Pseudomonas aeruginosa*, *Serratia mercescens*, *Bacillus pumillus*, and *Staphylococcus aureus*, with *Lactobacillus* species, *Micrococcus species* and *Staphylococcus aureus* having the highest levels of occurrence, having been isolated from all the samples analyzed. The high microbial colony counts and the presence of the above isolated bacteria may very well be related with free prevalence of some diseases experienced by some people consuming locally prepared *Fura da Nono*, especially students of Bingham University Karu, community. Since '*Fura da Nono'* serve as one of the major source of beverages for the inhabitants of Karu Local Government Area. It is recommended that bacteriological examination of the food be carried out periodically so as to assess their suitability for consumption also regulatory agencies should carry out surveillance on hawkers of the food and public enlightenment campaign should be embarked upon. . Based on the result with the use of use of spearman's rank correlation there is high correlation between the low percentage of the isolated bacteria from the control fura samples and the high percentage of bacteria detected from the test fura. (R= 0.8) Based on the result the level of bacterial load gotten from the Masaka, Auta, and Nyanya is higher than that of the control (Habib fura).

Keywords: Fura da Nono, Spearman's ranked correlation coefficient, R Bacteriological examination.

BACKGROUND OF THE STUDY

Fura is one of the several indigenous food products made from cereals in West Africa particularly Nigeria, Ghana and other countries. Fura is mainly produced from moist cereal flour, blended with spices, compressed into balls and boiled for 30 minutes. While still hot, the cooked dough is mashed in the mortar with the pestle (with addition of hot water) until a smooth, slightly elastic, cohesive lump (fura) is formed. The fura dough is rolled into balls by hand and dusted with flour. Fura is made into porridge by crumbling the fura balls into '*nono*' (local yoghurt produced from cow milk) this food combination is called "fura dan nono" or mashed in water before consumption in the form of porridge. Sugar or honey may be added to taste. Fura serves as a staple food and beverage for many adults and weaning food for infants. Cereals are considered to be of lower nutritive value due to their low protein content and limitations in certain essential amino acids such as lysine and threonine. Like most cereal-based foods, fura is a good source of carbohydrates but low in protein and fat. This makes fura nutritionally deficient. Increasing nutritional awareness of today's consumers continue to decrease the acceptance of such products.

Supplementation of commonly consumed cereal-based foods with inexpensive plant protein sources has been exploited to improve the protein quality of staple foods through a mutual complementation of their limiting amino acids.

This paper presents the results of a survey on the traditional production and consumption pattern of fura. The objective is to document such baseline information needed to provide guidelines for upgrading the production and nutritional quality of the product.

LITERATURE REVIEW

Fermentation of cereals for the production and preservation of food has been practiced throughout Africa [1, 5]. A variety of cereal-based fermented food are produced at both mini-industrial and household in most parts of Africa such as Kenkey (Ghana), Injera (Ethiopia), Mahew (Benin), poto-poto (Congo), agidi, ogi, kunun-zaki, fura (Nigeria), Uji and Togwa (Tanzania) and Kisra (Sudan) which are mostly used as weaning foods for infants and children as well as adult [1, 2, 4, 5]. The fermentation process leads to food preservation and increase in the organoleptic properties due to the production of lactic acid and other compounds that enhances the taste and flavor of the product [3].

Fura is an indigenous fermented cereal based foods majorly consumed in the Northern part of Nigeria. It is a thick ball snack that is produced mainly from millet or sorghum and spices such as ginger, pepper, black pepper and gloves. It is a semi-solid dumpling meal made from millet or sorghum and is used traditionally as stable food in most West African countries including Nigeria and Ghana [5-7]. During the preparation of *fura*, the cereal grains, Millet or sorghum are soaked in water and allowed to ferment overnight and then drained. The grains are allowed to dry, ground into fine powder and then mixed with hot water with continuous stirring to form a smooth paste which are then molded into balls and cooked. The molded balls are allowed to ferment for 1-4 days at room temperature. The balls are pounded and re-molded and then sun-dried which can also be dry-milled into powder which is reconstituted in water to get *fura* meal. Also, the cooked dough balls can be broken and mixed with fermented milk (nunu) to form *fura* de nunu which can serve as a complete food providing energy and protein [1, 5, 8].

The global importance of cereal crops to human diet and, moreover, to the written history of man and agriculture cannot be overstated. Cereal grains are the fruit of plants belonging to the grass family (Poaceae). Cereal crops are energy dense, containing 10000–15000 kJ/kg, about 10–20 times the energy of most succulent fruits and vegetables. Nutritionally, they are important sources of dietary protein, carbohydrates, the B complex of vitamins, vitamin E, iron, trace minerals, and fiber. It has been estimated that global cereal consumption directly provides about 50 percent protein and energy necessary for the human diet, with, cereals providing an additional 25 percent protein and energy via livestock intermediaries [9]. Some cereals, notably wheat, contain a protein called gluten, which is essential for making leavened bread. Although dried cereal grains constitute living cells that respire, when kept in an appropriate environment, whole grains can be stored for many years [9]. Asia, America and Europe produce more than 80 percent of the world's cereal grains. Wheat, rice, sorghum and millet are produced in large quantities in Asia; corn and sorghum are principle crops in America and barley, oats and rye are major crops in the former USSR and Europe [10].

Africa is one of the lowest producers of cereals globally. Major cereals grown in Africa include maize, rice, sorghum and millet. Cereals are more widely utilized as food in African countries than in the developed world. In fact, cereals account for as much as 77 percent of total caloric consumption in African countries and contribute substantially to dietary protein intake in a number of these countries. The majority of traditional cereal-based foods consumed in Africa are processed by natural fermentation. Fermented cereals are particularly important as weaning foods for infants and as dietary staples for adults [9].

Chemical components of cereal grains

Compositionally, cereals consist of 12-14 percent water, 65-75 percent carbohydrate, 2-6 percent lipid and 7-12 percent protein. Cereals are quite similar in gross composition: being low in protein and high in carbohydrate [11].

The chemical components of cereals are not uniformly distributed in the grain hull and bran is high in cellulose, pentosans and ash. The aleurone layer of wheat contains 25 times more minerals than the endosperm, whereas the lipids are generally concentrated in the aleurone and germ. The endosperm, which contains mostly starch, has lower protein content than the germ and the bran, and is low in fat and ash [9].

Nutritional quality of cereals

Cereal grains are low in total protein compared to legumes and oil seeds. Lysine is the first limiting essential amino acid for man, although rice, oats and barley contain more lysine than other cereals. Corn protein is also limiting in the essential amino acid tryptophan, while other cereals are often limiting in threonine. The annual global yield of essential amino acids from major cereals has been compared to a hypothetical population of 3 billion adults and 2 billion children [12]. Accordingly, if all cereals were effectively and fully utilized for human consumption

they would more than meet humanity's needs for essential amino acids.

Barley, sorghum, rye and oat proteins have lower digestibility (77-88 percent) than those of rice, maize and wheat (95-100 percent). The biological value and net protein utilization of cereal proteins is relatively low due to deficiencies in essential amino acids and low protein availability [10]. Cereals also provide B-group vitamins and minerals, although refining results in losses of these nutrients [13].

Pearl millet

Pearl millet, *Pennisetum glaucum* is also known as spiked millet, and bulrush millet [14]. Pearl millet may be considered as single species but includes a number of cultivated races. It almost certainly originated in tropical western Africa, where the greatest numbers of both wild and cultivated forms occur. About 2000 years ago the crop was carried to eastern and Central Africa and to India, where, because of its excellent tolerance to drought, it become established in the drier environments [15].

The height of the pearl millet plant may range from 0.5 to 4m and the grain can be nearly white, pale yellow, brown, grey, slate blue or purple. The ovoid grains are about 3 to 4 mm long, much larger than those of other millets, and the 1000-seed weight ranges from 2.5 to 14 g. The size of the pearl millet kernel is about one-third that of sorghum. The relative proportion of germ to endosperm is higher than in sorghum [15].

Nutritional Quality and Potential Health Benefits of Millets

Nutritional quality of food is a key element in maintaining human overall physical well-being because nutritional well-being is a sustainable force for health and development and maximization of human genetic potential. Therefore, for solving the problem of deep-rooted food insecurity and malnutrition, dietary quality should be taken into consideration [16]. Millet proteins are good sources of essential amino acids except lysine and threonine but are relatively high in methionine. Millets are also rich sources of phytochemicals and micronutrients. Millets are good sources of phytochemicals such as phenolic acids, lignans and phytoestrogens. Phenolic acids like p – coumaric acid and vanillic acids are present in the bran layer of the grains and are mainly present as gently bound form with insoluble polymers. Generally, grains contain low to moderate levels of tocopherol due, but to the large amount consumed in Korean diet, they provide a significant and consistent source of tocopherols. Tocopherols are regarded as intracellular antioxidants due to their activity of inhibiting the peroxidation of polyunsaturated fatty acids in biological membranes.

Common millet was found to contain 1.8 to 3.9 percent lipids, and about 24 percent of the grain fat is in the embryo component. The fatty acid profile showed that saturated fatty acids totaled 17.9 to 21.6 percent while unsaturated fatty acids totaled 78 to 82 percent. The unrefined fat extracted from the kernel of common millet contained 8.3 to 10.5 mg vitamin A and 87 to 96 mg vitamin E per 100 g. On refining, all the vitamin A activity was lost and there was significant loss in vitamin E. Vitamin E is also present in the fat extracted from sorghum grain.

Millet and Fermentation of Cereals

There is an increased interest in the production of flours from locally available and abundantly grown grains and pulses and fermentation is one of the choice methods employed. Fermentation is an age long method of processing cereals and legumes [17]. It modifies some physical characteristics of cereals and legumes, increases the level of some nutrients, digestibility and bioavailability [18, 19], decreases levels of antinutrients, increases nutrient density [20] and imparts some antimicrobial property [21, 22]. According to [23], fermentation of grains and oil seeds results in increased nutritional value and wholesomeness over the starting material and it may also lead to changes in vitamin levels. Fermentation actually holds promise as a food processing method that can be used to diversify the food uses of some under exploited plant foods like millet.

Millet is a good protein source but it is underutilized. Millet (*Pennisetum americanum*) is one of the cereals produced extensively in Nigeria. Nigeria produces 21% of the world's total millet [25]. Millet contains about 67% carbohydrate, and 12% protein. The seed is high in ash, iron, and phosphorus and is an important source of the B group of vitamins [10]. The essential amino acid profile of millet indicates that it contains more lysine, threonine, methionine and cysteine than sorghum [10]. Despite the rich nutrient content of millet, its use in Nigeria is limited to the production of household porridge-type breakfast gruel (*akamu dawa*) and dough (*fura*).

Fura

Fura can be considered to be functional natural food since the raw material (millet) has been reported to have protein content up to 11% protein by weight and are rich in B vitamins such as niacin, B6 and folic acid, iron, potassium, zinc, magnesium, and calcium with no gluten content. They are also rich in phytochemicals, including phytic acid which is believed to lower cholesterol and reduce the risk of cancer. Moreover, cereals regarded as functional foods since they provide dietary fibre, energy, protein, minerals, vitamins and anti-oxidants required for human health [24]. However, *fura* has a short shelf life of 3 to 4 days at the temperature of about 5°C and 1 to 2 days at room temperature of 25°C while at 35°C it can only last for 18 hours with unacceptable quality, after which they can be deteriorated by microorganisms whose presence

poses health risk as they can be source of infection when consumed [5, 26]. Moreover, poor handling of *fura* during processing, storage and marketing can predispose it to microbial contamination as they are molded into balls by hand during preparation, and storage may be in an unhygienic containers and environment [27]. Also, improper handling and post-fermentation processing such as pounding in mortar, molding and the point of sale can expose the *fura* product to microbial contamination [1].

Process of *Fura* preparation

The main ingredients for *fura* processing are the pearl millet (*Pennisetum* spp.*)* and spices such as pepper, cloves, mint and ginger. The scales of operation for the processing units surveyed varied based on the quantity of millet processed daily. The amounts ranged from about 6 kg to 27 kg, with an average of about 12 kg. There were also some significant variations in the processes, as regards the techniques used and the parameters involved. Figure 1 summarizes the traditional *fura* process, with the variations observed. As the first step, some processors DE hull the millet grains while others soak the grains without DE hulling. The duration of soaking varies, ranging from about 18 hours to 28 hours, and with an average of about 23.3 hours. At all the processing units visited, washing of the grains before milling was practiced. This constitutes the second major step in processing millet into *fura*. The extent of washing apparently depends on the quantity and quality of the raw material (millet). Following washing, wet milling is done using the plate attrition mill. It is during this time that the ingredients (pepper, mint, cloves, and ginger) are added. Some processors ferment the dough formed. Depending on the variations in the processes as depicted in Figure 1, three different doughs result; the dehulled grain unfermented dough (DGUD), the soaked grain fermented dough (SGFD), and the dehulled grain fermented dough (DGFD). Once the doughs are produced, they are hand-moulded into balls of about 10cm in diameter and then cooked for about 30 minutes. The cooked millet balls are pounded with a mortar and pestle. They are finally moulded into much smaller balls for sale. The balls may be coated with maize flour before being packed for sale. The shelf stability of the final product at ambient conditions was noted to vary from 1 to 6 days. The duration varied depending on the producer's expertise and processing techniques. Indicators of spoilage included mold growth, caking, and excessive souring resulting from continuous fermentation after processing. All unit operations were observed to be performed under uncontrolled, open environmental conditions. The DE hulling and milling are done at small commercial community milling centers. The main by-product of *fura* processing is the chaff resulting from the partial DE hulling and winnowing which consists of the hulls and sometimes the germs of the millet grains, and is used as animal feed.

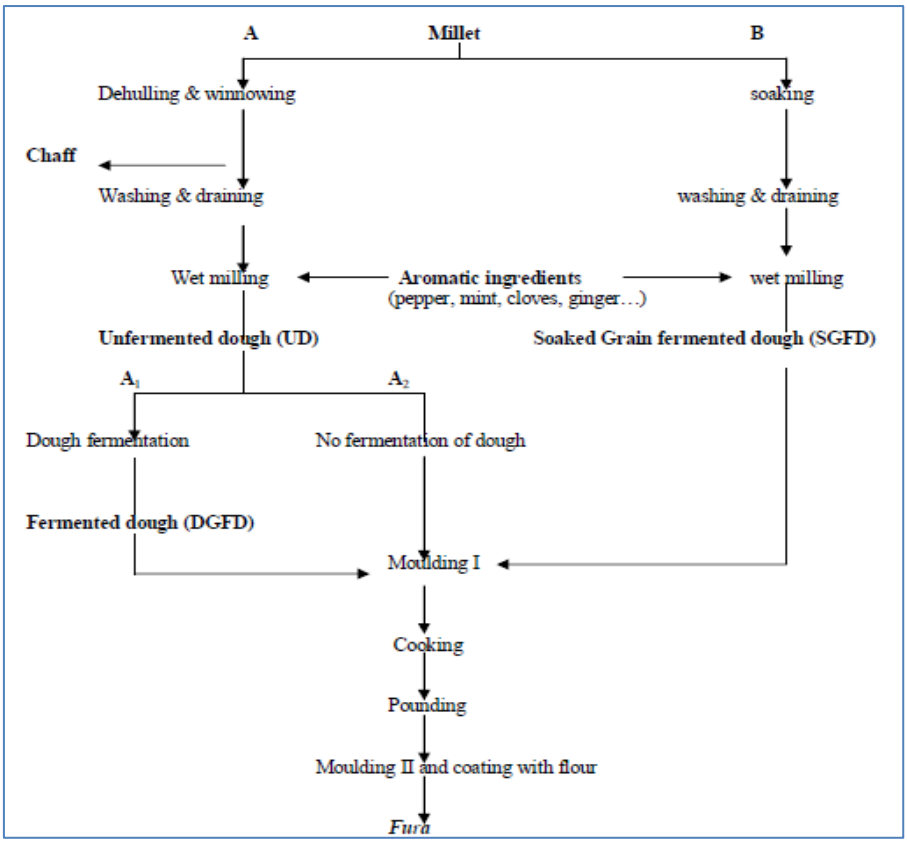

Fig-1: Flow diagram for the traditional processing of *fura* using different millet dough preparations [1].

Bacterial Contamination of *Fura*

The fermentation process in *fura* is achieved through spontaneous fermentation using indigenous bacteria and yeast inherent in the cereals. However, reports indicate that lactic acid bacteria genera such as *Lactobacillus, Pediococcus, Streptococcus* and *Enterococcus* species as well as yeasts such as *Saccharomyces cerevisiae, Pichia anomala* and *Candida* species are associated with cereal fermentation [5, 28, 29]. During fermentation, lactic acid and other organic acids accumulate resulting to a decrease in the pH due to microbial activities thereby inhibiting the growth and survival of spoilage and pathogenic organisms depending on the type of organism and the temperature of the medium [5, 30]. However other organisms have been isolated from *fura*. For instance, isolated *Lactobacillus, Pediococcus, Streptococcus, Leuconostoc, Enterococcus, Enterobacter aerogenes, Klebsiella pneumonia, Proteus vulgaris, Enterobacter sakazakii, Serratia liquefaciens, and Escherichia coli. Issatchenkia orientalis, Saccharomyces cerevisiae, Pichia anomala, Candida tropicalis, Saccharomyces pastorianus, Yarrowia lipolytica*, and *Galactomyces geotricum* has been reported [1].

METHOD

Study area

The study was carried out in Karu Local Government Area of Nasarawa State, Nigeria between the months of January and May, 2015. The geographically situated on the latitude $8^{o}50^{o}$N and longitude $7^{0}52^{0}$E. Karu local government area is on latitude of 850^{0} above sea level and it is in the northwest of lafia, the state capital of Nasarawa state, it is 53km away from Abuja (capital of Nigeria) in the guinea savannah of Nigeria.

Study design

Samples were randomly taken from three different locations in karu (Masaka, Auta, Nyaya) and as standard Habib fura was used (NAFDAC Approved) in order to find the level of bacterial contamination between them.

Sample collection

The Fora samples were collected from Karu Market in a sterile container and were transferred to the laboratory. (Microbiology laboratory of Bingham University, Karu) where the proper experiment.

Sampling procedure

Fura was in the laboratory following the method described by [8]. Exactly 700 g of millet was weighed using analytical weighing balance. The weighed millet was cleaned of foreign materials, washed with clean water and cleansed with sterile distilled water. The cleaned sample was steeped in sterile distilled water overnight. The steeped sample was drained, spread on aluminum foil and dried using hot air oven at 60°C for 8 hours. The dried samples were ground into powder using laboratory grinder, and then mixed with hot sterile distilled water until a smooth paste is formed. The paste was molded into balls and left at room temperature to ferment for 48 hrs. The fermented samples were dried at 60°C for 8 h in hot air oven. The dried balls were dry-milled into powder which can be reconstituted with water to form *fura*.

Media Preparation

All the media used were prepared according to the manufacturer's guide. Nutrient and MacConkey agar were used for the isolation of bacteria.

Serial Dilution

Five-fold serial dilution was carried out using sterile distilled water as the diluents. 5 test tubes containing ten milliliter volume per volume (10mllv/v) of sterile distilled water were used for each of the sample. They were labeled and arranged appropriately in a test tube rack. 10ml of the sample was serially diluted in test tubes containing 10ml of distilled water using a sterile syringe, each transfer was followed by a gentle agitation in other to mix the contents uniformly. The procedure was repeated for all the diluents in the same manner. The serial dilution was performed aseptically beside a lit Bunsen burner to prevent contamination.

Isolation Procedure

Each of the samples was isolated by inoculating respectively 0.1ml of 10^{6} and 10^{7} of the serially diluted pap samples in an already prepared Nutrient and MacConkey agar using the spread plate method. The sample was taken from the test tube aseptically using a sterile syringe near a lit Bunsen burner. The plate was allowed to gel properly and was incubated at 37^{o} C for 24-48 hours. This plate was tagged as primary isolate:

Plate Count

The Nutrient and MacConkey agar culture plate were examined after 24 hours of incubation. The number of bacteria colonies on the plate which had between 30-300 colonies were counted and the viable number /colony forming units was calculated while the colonies that were too numerous to count (TNTC) was discarded. After incubation, the plates were examined for colonies that appeared different in their cultural characteristics. These colonies were collected with a sterile wire loop and was streaked on an already prepared Nutrient and MacConkey agar to obtain pure cultures. Each pure culture was then sub-cultured into agar slants in bijou bottles and kept as stock culture.

Identification of Microbial Isolates

The identification of bacteria was carried out based on the classification scheme given in Bergey`s manual of determinative bacteriology. Bergey`s manual

relied on the empirical classification system that separated all bacteria into 19 groups based on the basis of morphology, physiology, growth requirement and biochemistry. The discrete colonies of the bacteria isolates were identified based on the colony morphology, gram staining and biochemical tests.

HYPOTHESIS

Ho; there is no correlation between the relatively low bacterial growth in the control fura sample and high bacterial growth of the organisms in the test samples.

$H_{a;}$ there is high correlation between the relatively low bacterial growth in the control Fura sample and high bacterial growth of organisms in the test samples.

RESULTS COLLECTION AND ANALYSIS

The result of the total viable bacterial counts of the samples (MSK, AUT, and NNY) was shown in table 1. The results obtained ranged from 4.0 x 10^4 cfu/ml to 7.0 x 10^4 cfu/ml with AUT having the highest microbial load. Biochemical characterization for bacterial isolates from the samples was presented in table 2. The bacteria were identified as genus Bacillus, Pseudomonas, *Staphylococcus* and *Serratia*. Percentage of occurrence was presented in table 3.

Staphylococcus aureus were more frequently isolated and constituted the highest number of the total bacteria isolated Escherichia coli were isolated on the EMB agar presented in table 4. E. coli showed a characteristic green metallic sheen on EMB agar.

1.5 . RESULTS ANALYSIS

Table-1: Total viable bacterial count

Samples	Viable count (CFU/ML		
	Plat 1	Plat 2	Average
MSK	4.0 x 10^4		4.0 x 10^4
AUT	7.0 x 10^4		7.0 x 10^4
NNY	5.1 x 10^4		5.1 x 10^4

CFU/Ml: colony forming unit per milliliter
Key: MSK: Masaka; AUT: Auta, NNY: Nyanya

Table-2: Morphology and Biochemical Characterization of the Bacteria Isolates

	Bac 1	Bac 2	Bac 3	Bac 4	Bac 5	Bac 6	Bac 7	Bac 8
Shape	Bacilli	Bacilli	Cocci	Bacilli	Bacilli	Bacilli	Bacilli	Bacilli
Gram reaction	+ve	- ve	+ve	-ve	+ve	+ve	+ve	-ve
Arrangement	Chains	Clusters	Clusters	Single	Single	Chain	Cluster	Single
Motility	-	-	-	+	+	+	+	+
Catalase	-	+	+	-	+	+	+	+
Coagulase			-	-	-	-	+	+
Citrate	-	+	-	+	+	+	-	-
Indole test	-	-	-	-	+	-	+	+
Methyl red	-	-	-	+	-	-	+	+
Glucose	+	+	+	-	+	+	+	-
Lactose	+	+	-	+	+	+	+	-
Sucrose	+	+	+	+	+	-	+	-
Probable identity	*Lactobacillus SPP*	*Klebsiella Species*	*Micrococcus Species*	*Pseudomonas acruginosa*	*Settatiu mercescens*	*Bacillus pumillus*	*Staphylococcus aureus*	*Salmonella SPP*

Table-3: The occurrence of the isolated organisms in all the samples of fura analyzed

Designation	Bacteria Isolates	MSK	AUT	NNY	Total	Control	%
BAC 1	*Lactobacillus species*	3	3	3	9	1	15.8
BAC 2	*Klebsiella Species*	3	3	2	8	0	14
BAC 3	*Micrococcus Species*	3	3	3	9	0	15.8
BAC 4	*Pseudomonas acruginosa*	3	2	2	7	1	12.3
BAC 5	*Serratiu mercescens*	1	2	1	4	0	7.0
BAC 6	*Bacillus pumillus*	2	3	2	1	1	12
BAC 7	*Staphylococcus aureus*	3	3	2	8	1	14
BAC 8	*Salmorella SPP*	2	2	1	5	0	8

Key: MSK = Masaka, AUT: Auta, NNY= Nyanya
BAC 1 = Bacteria Specie 1, BAC 2 = Bacteria specie 2 --- BAC 8 = Bacteria Specie 8

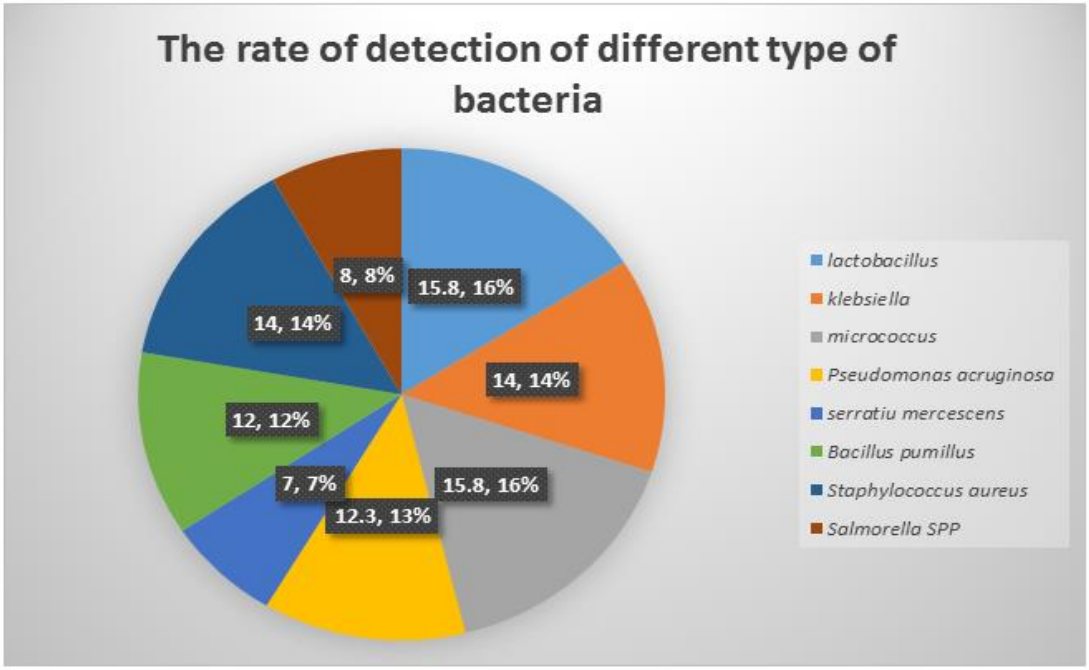

Fig-2

Table-4: Occurrence of bacterial detected in the commercial and NAFDAC approved (Habib fura)

Organisms	MSK 1	MSK 2	MSK 3	AUT 1	AUT 2	AUT 3	NNY 1	NNY 2	NNY 3	Total
Lactobacillius species	+	+	+	+	+	+	+	+	+	+
Klebsiella species	+	+	+	+	+	+	+	-	+	-
Micrococcus species	+	+	+	+	+	+	+	+	+	-
Pseudomonas aerusineba	+	+	+	-	+	+	+	+	-	+
Serratia mercescens	-	-	+	-	_	+	+	-	-	-
Bacillus Pumillus	+	+	-	+	+	+	-	+	+	+
Staphylococcus aureus	+	+	+	+	+	+	+	+	-	+
Salmonella SPP	-	+	+	+	+	-	+	-	-	-

Key: MSK: Masaka, AUT: Auta, NNY: Nyanya, BAC 9= Bacteria number 9.

Table-5: Percentage rate of detection of isolated bacteria in the test and control samples

Bacteria	Msk	Aut	Nny	Control	Total	%test samples	% control
Lactobacillus species	3	3	3	1	9	9/10=0.9	1/10=0.1
Klebsiella species	3	3	2	00	8	8/8=1.0	0/8=0
Micrococcus species	3	3	3	0	9	9/9=1.0	0/9=0
Pseudomonas aerusineba	3	2	2	1	7	7/8=0.8	1/8=0.1
Serratia mercescens	1	2	1	0	4	4/4=1.0	0/4=0
Bacillus Pumillus	2	3	2	1	7	7/7=1.0	1/7=0.1
Staphylococcus aureus	3	3	2	1	8	8/8=1.0	1/8=0.1
Salmonella SPP	2	2	1	0	5	5/5=1.0	0/5=0

Table-5: Percentage rate of detection of isolated bacteria in the test and control samples

Bacteria	D	R_1	Control	R_2	$d(R_1-R_1)$	d^2
Lactobacillus species	0.9	2	0.1	2	0	0
Klebsiella species	1.0	3	0	1	2	4
Micrococcus species	1.0	3	0	1	2	4
Pseudomonas aerusineba	0.8	1	0.1	2	-1	1
Serratia mercescens	1.0	3	0	1	2	4
Bacillus Pumillus	1.0	3	0.1	2	1	1
Staphylococcus aureus	1.0	3	0.1	2	1	1
Salmonella SPP	1.0	3	0	1	2	4

$\sum d^2 = 19$

$R = \frac{1 - 6\sum d2}{n(n^2-1)}$

$R = \frac{1-6\times19}{8\times(8^2-1)}$

$= 1 - \frac{119}{8\times(64-1)}$

$= 1 - \frac{119}{50}$ $= 1 - 0.236 = 0.764$

DISCUSSION, CONCLUSION AND RECOMMENDATION

Discussion

Fura is an indigenous fermented cereal-based and very nutritious food mostly consumed in Northern Nigeria. However, it's potential to serve as a source of disease transmission due to contamination by pathogenic microorganisms during preparation, storage and marketing cannot be over-emphasized, especially that fura is consumed fresh, and un-cooked.

In the present study, the PH in water of all the fura samples studied was within the acidic range. This acidic property of fura can be traced to the addition of spices such as presence of some lactic acid producing bacteria during overnight fermentation process. The PH values of fura0 in this study agree with the report of PH values ranging from 4.10 to 5.00 in fura samples in Ghana [1].

This study is also similar to the PH value of Kunun-zaki (a non-alcoholic cereal-based fermented beverage samples in the range 4:00 to 4:30 in Ogun State Nigeria. The low PH are desirable since reports indicate that it inhibits the growth and survival of spoilage organisms and give fermenting organism and advantage since reports indicates that it inhibits the growth and survival of spoilage organisms and give fermenting organisms and advantage. This low PH values can also be attributed to the presence of lactic acid bacteria which produced acid during fermentation which lower the PH.

The bacteria load of the laboratory prepared fura showed high bacteria and lactic bacteria loads. The counts observed could be due to the laboratory conditions as well as the length of fermented. The counts for commercial Fura showed that the total bacteria count ranged from 4.0 x 10^4 to 7.10^4 cfu/ml. the counts were quite high; however, similar count has been reported on *fura da nono* samples ranging from 2.0 x 10^7 cfu/g to 2.23 x 10^8 cfu/g.

The result of the present study agrees with the report of a study carried out in Bauchi, Nigeria which reported bacteria load of 3.2 x 10^4 cfu/ml to 4.7 x 10^4 cful.ml in fura samples [27].

The high bacteria load in these studies could be attributed to contamination by the utensils used during processing and the hygiene of the producers. It could also be attributed to the inherent microorganisms in the raw materials and contamination through the environment, as well as the processing equipment and processing water [1]. The total lactic acid count range in this study is high, and agreed with similar report, recorded on sorghum based ogi (Pap). Such high lactic acid bacteria count could be attributed to the low PH values which favored their growth or the fermentation conditions that tend to favour the growth of lactic acid bacteria (LAB). High incidence of bacterial population consistent with the present finding has been reported.

The high bacteria counts found in this study could be as a result of microorganism already present on the cereal grains from which the fura was produced, which continue to grow in the product. Also, it could be attributed to contaminate during storage, processing and handling, especially from water used for processing, probably due to inadequate supply of portable water in the study area.

In the present study, the organisms identified from the various samples of Fura are; Lactobacillus species, *Escheridia coli, klebsiella* species, *Micrococcus* species, *Baccilus* species, *Staphyloccus* aureus and *Salmonella* species. The organism isolated from the control sample were mostly the lactic acid bacteria. This observation is consistent with previous works that reported the presence of *Lactobacillus, Streptococcus, Klebsilla* species, and *Streptococcus* species can be attributed to the fact that they are commonly found in the environment, and have been reported to be common contaminants of food.

However, their presence in commercial samples in this study are of public health concern since some of the organisms are associated with some form of disease conditions. For instance, *Staphylococcus aureus* causes disease in human such as folliculitis, scalded skin syndrome, pneumonia, erysipelas, toxic shock syndrome, meningitis food borne intoxication, due to their ability to elaborate heat stable toxin. *Pseudomonas* species is widely distributed in soil and water and can therefore contaminate food products, which could lead to infection, when ingested species can cause fever, neck stiffness, urinary tract infections, meningitis, pneumon*). Klebsiella* and nosocomial infection.

Some strains of *Escherichia coli* cause haemorrhagic charrhoea, and intoxication. Baccilus can also cause food borne intoxication while *proteus* and *streprococcus* species are also implicated in urinary tract infection, nausea, vomiting and diarrhea in human.

The percentage occurrence of the isolates from fura in the present study showed that lactobacillus species and *micrococcus* species were the most common (9) (90%), followed by klebsiella species, and staphylococcus aureus (8) (80%), *Bacillus purillus* and

Pseudomonas aeruginosa (7) (70%), Salmonella species (5) (50%) while *Escherichia coli* and *serratia mercescens* were the least with 4(40%). This result agreed with the report of higher percentage occurrence of lactic acid bacteria in *Fura de Nono* respectively [1]. Also it is reported that the lactic acid bacteria are the predominant organisms in cereal fermentation. Moreover, lactic acid bacteria have been found to predominate the fermentation of maize and sorghum for ogi (pap) production.

Although, *Staphyloccus aureus, Klebsiella species, Proteus species, Bacillus species, Pseudomonas species. Escherichia coli,* and *Streptococcus* species have been isolated from Fura and other cereal-based foods as shown by researchers, their presence as contaminants are treat to public health, hence the need for proper hygienic mealines dung preparation and storage of fura foods.

Based on the result from the use of spearman's rank correlation there is high correlation between the low percentage of the isolated bacteria from the control fura samples and the high percentage of bacteria detected from the test fura which is shown in table 5.

Conclusion

The present study has shown high bacterial load in the commercial fura sample studied. Also it has shown the presence of potential pathogenic bacteria which are the public health significance. These organisms are associated with unhygienic environments poor handling during processing, marketing and storage. Therefore there is need for proper handling to avoid outbreak of diseases that could be associated with the organisms encountered in this study.

Recommendation

The study recommends as follows;

1. There should be proper regulation by concerned agencies to enable fura to be produced in a hygienic environment, and with good manufacturing practices.
2. There should be public enlightenment about the danger of poor and unhygienic practices of fura production, as well as the benefits (health benefits) when fura is produced, marketed and stored in a hygienic environment, and with good manufacturing practices.
3. Since fura da nono serve as one of the major source of beverages for the inhabitants of the study area, bacteriological examination of the foods should be carried out periodically, so as to assess their suitability for consumption

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