ASSESSEMENT OF MICROBIAL LOAD IN FURA AND NONO SOLD IN FEDERAL UNIVERSITY, GASHUA, YOBE STATE, NIGERIA

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ABSTRACT

The conventional procedure of making Fura and processing Nono and its products exposes them to microbial contamination. Additionally, the products' handlers' lack of hygiene may cause harmful microorganisms to enter them. The study investigated Microbial load analysis of Fura and Nono sold in Federal University Gashua, Yobe State. Three samples of Fura and Nono were purchased from three spots on the campus making a total of nine. Bacterial counts were carried out using the pour plate technique and bacteria were isolated from the Fura and Nono. The occurrence prevalence of bacterial species with the highest rate in this study are Escherichia coli (23.1%), Staphylococcus aureus (15.38%), Pseudomonas aeruginosa and Salmonella typhi (10.25%) for Nono, while Fura include Escherichia coli 31.03%, Staphylococcus aureus 20.69%, Enterobacter specie and Salmonella epidermidis 10.34%. All the samples were contaminated with bacteria, some with more than two or three. These could expose users of this product in the sample locations to foodborne infections and certain associated illnesses. Processing, packaging and marketing of Fura and Nono should be carried out in a hygienic environment to avoid contamination.

Keywords: Fura, Nono, food contamination, bacteria, pathogenic microorganism, poor hygiene.

INTRODUCTION

Fura da nono is a staple dish in northern Nigeria where it had mostly as lunch. 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 (Maud, 1990). It is usually served chilled in commercial outlets with or without sugar depending on individual tastes.

The fura balls are made from millet flour which has been spiced with ginger, cloves and sometimes, pepper and made into balls. A whole grain rich in protein, antioxidants, and other nutrients, millets offer a host of health advantages, including lowering cholesterol and blood sugar. Because millet is gluten-free, it's a great option for those with celiac disease or on a gluten-free diet.*www.healthline.com/nutrition/what-is-millet*. The phenolic properties found in millets compromise phenolic acids, flavonoids, and tannins, which are beneficial to human health (Hassan

et.al., 2021). Fura is mostly made by combining spices with moist cereal flour, compressing it into balls, and boiling it for half an hour. The baked dough is pounded with a pestle and mortar while still hot, adding hot water as needed, until a cohesive lump known as fura forms. After being coated with flour, the fura dough is manually formed into balls. Kwarteng *et.al* (2021).The local method of fura production; the unsterilized utensils, contaminated water, dirty and unhygienic environment can be a source of an inanimate vector of infectious microbes and/or toxins.

Nono' is a locally fermented cow's milk sold by the Fulani women and other vendors which is generally accepted and consumed in the northern part of Nigeria. According to Richter et al. (1992) fresh milk from a healthy cow typically has a low microbial load (less than 1000 ml. but the loads may increase up to 100-fold or more once it is stored for some time at normal temperature. The fermentation of lactic acid aids Nono. Egwaikhide et al., (2014). described the production nono as follows- fresh milk is directly obtained from a cow into a properly washed calabash and kept wide open in the sun for approximately two hours to facilitate the separation of the fat layer. A quantity of overnight fermented milk is added to serve as a source of starter culture. Nono is created when large volumes of water are added to the curdled sour milk, which is then stirred with a T-shaped stick to a liquid of fine consistency.

Microbial contaminations of fura and nono occur before, during and after fermentation due to poor hygienic practices and exposure to an unhealthy environment. This study examines the microbial load of fura and nono sold in Federal University, Gashua, Yobe State and its implications on the consumers.

Materials

Three samples of Nono and fura were purchased from three spots on the campus making a total of nine

METHODS

Media preparation

Nutrients Agar

A conical flask was used to weigh 28 grams of nutrient agar and dissolve it in 1000 mls distilled water. The conical flask's mouth was sealed with cotton wool wrapped in aluminum foil and secured with masking tape to prevent leaks and contamination. An autoclave set to 121 ^{o}C for 15 minutes sterilized the media. It was removed and allowed to cool down.

Sterilization of glass wares

All intended used glass wares were washed with tap water and detergent and later placed in hot air oven set at 160 ^{o}C for 30 minutes. The hot air oven was switched off and the glass wares were left to cool until use.

Serial dilution

Exactly 1g of each of the food samples were immersed in sterilized peptone water and allowed to dissolve. Five (5) sets of sterilized test tubes were labelled as 10^{-1}, 10^{-2}, 10^{-3}, 10^{-4}, and 10^{-5} respectively. All the tubes were filled with 9ml distilled water. 1ml was taken from the stock of peptone water and transferred into the second test tube, 1ml from the second test tube was transferred and mixed thoroughly. The process continued until the last tube was reached.

Sample inoculation (pour plating technique)

0.5ml was dispensed into each of the sterilized petri plates, and the molten media was poured into the plates and gently mixed with the sample. The media was allowed to solidify and incubated in an incubator set at 37 ^{o}C for 24 hours. All plates were placed in an inverted position until the growth of bacterial colonies was clearly observed.

Gram's staining techniques

1. A clean grease-free glass slide was obtained
2. Distilled water was dropped at the center of the slide, a bacterial colony was picked with a sterilized inoculation loop and emulsified on the glass slide.
3. A thin smear was obtained and heat-fixed by passing it three times through a Bunsen burner flame.
4. The smear was flooded with crystal violet for 60 seconds
5. It was gently rinsed with slow-running tap water.
6. Lugol's iodine was added and covered the smear for 60 seconds
7. It was gently rinsed with tap water
8. The smear was decolorized with 95% alcohol for 10 seconds
9. The smear was counterstained with safranin for 30 seconds

It was allowed to air-dry and examined under a 100× oil immersion objective lens magnification.

Colony Counting

After 24 hours incubation, the bacterial colonies growth were observed on various plates and the colonies were counted using digital colony counter and colonies were estimated using this formular:

$$\frac{\text{Number of Colonies} \times \text{dilution factor}}{\text{Vol. of sample}}$$

Macconkey Agar

55g of Macconkey agar was weighed and dissolved in 1000mls distilled water in a conical flask. The mouth of the conical flask was plugged with cotton wool wrapped in aluminium foil and tightened with masking tape to avoid spillage and contamination. The media was sterilized in an autoclave set at 121 ^{o}C for 15 minutes. It was removed and allowed to cool.

Eosin Methelene Blue Agar (EMB-A)

36g of EMB agar was in 1000mls distilled water in a conical flask. The mouth of the conical flask was plugged with cotton wool wrapped in aluminium foil and tightened with masking tape to avoid spillage and contamination. The media was sterilized in an autoclave set at 121^{o}C for 15 minutes. It was removed and allowed to cool.

Manitol Salt Agar (MSA)

111g of Manitol salt agar in 1000mls distilled water in a conical flask. The mouth of the conical flask was plugged with cotton wool wrapped in aluminium foil and tightened with masking tape to avoid spillage and contamination. The media was sterilized in an autoclave set at 121^{o}C for 15 minutes. It was removed and allowed to cool.

Simon Citrate Agar

24.28g was in 1000mls distilled water in a conical flask. The mouth of the conical flask was plugged with cotton wool wrapped in aluminium foil and tightened with masking tape to avoid spillage and contamination. The media was sterilized in an autoclave set at 121^{o}C for 15 minutes. It was removed and allowed to cool.

Urea Agar Base

21g of urea agar base in 1000mls distilled water in a conical flask. The mouth of the conical flask was plugged with cotton wool wrapped in aluminium foil and tightened with masking tape to avoid spillage and contamination. The media was sterilized in an autoclave set at 121^{o}C for 15 minutes. It was removed and allowed to cool.

Tryptone Broth

15g in 1000mls distilled water in a conical flask. The mouth of the conical flask was plugged with cotton wool wrapped in aluminium foil and tightened with masking tape to avoid spillage and contamination. The media was sterilized in an autoclave set at 121^{o}C for 15 minutes. It was removed and allowed to cool.

MR-VP Broth Medium

Medium-medium MR-VP broth.

17g was dissolve in 1000mls distilled water in a conical flask. The conical flask's mouth was sealed with cotton wool wrapped in aluminum foil and secured with masking tape to prevent leaks and contamination. In an autoclave set at 121oC for 15 minutes, the media was sterilized. It was taken out and left to cool down.

Sub-culture on differential and selective media

Using sterilized inoculation loop, a loopful of bacterial colony was collected and inoculated on the media using streak plating technique. This was incubated at 37^{o}C for 18-24 hours. The appearance of bacterial colony was observed and recorded.

Biochemical tests

We must rely heavily on biochemical testing to identify bacteria. Each organism's biochemical reactions act as a thumbprint for its identification.

Catalase test

Enzymes that help decompose hydrogen peroxide into water and oxygen. One of the oxidative end products of carbohydrate metabolism is hydrogen peroxide. If this is allowed to accumulate in the bacterial cells, it can become fatal to the bacteria.

The 3% hydrogen peroxide is stored in a dark brown bottle under refrigeration, and the organism is cultured for 18 to 24 hours.

2. Oxidase test

Determine the presence of bacterial cytochrome enzyme oxidase. Cytochromes in aerobic respiration transfer electrons (H) to oxygen to form water. The reagent used is a dye p-phenylenediamide dihydrochloride (PPDD) acts as an artificial electron accepter substituting the oxygen

3-IMViC tests
IMViC: it's a group of tests used mainly to identify *Enterobacteriaceae* members which include:

1. Indole test

Indole is a component of the amino acid tryptophan. Some bacteria have the ability to break down tryptophan for nutritional needs using the enzyme tryptophanase, which is produced by some bacteria. Kovacs' reagent can be used to detect indole when tryptophan is broken down. A red color is produced on the surface of the test tube when Kovac's reagent reacts with indole.

MR-VPtest MR test:
The principle is to test the ability of the organism to produce acid end product from glucose fermentation. This is a qualitative test for acid production.

VP test:
The organisms are able to produce neutral end product from glucose fermentation. The procedure is follows:
The organism to be tested was inoculated into two tubes of MR-VP broth for 24 hours at 37 ^{o}C, after incubation, the MR and VP tests was performed tubes 1 and 2, by adding 6-8 drops of methyl red reagent.

RESULTS AND DISCUSSION

Bacterial colony

Figures 3.1a and 3.1b shows the colony of isolated bacteria in the samples. A bacterial colony represents growth of bacteria under heterogeneous conditions that are encountered on an agar plate when cells are inoculated onto an agar plate there is rapid growth. The results revealed that for Fura sample, the Main Gate (MG) has the highest no of bacterial colony 85.15%, followed by sample Glass House (GA) with 14.23%, while Fac. of Agric. (FA) sample has the lowest no of colony of 3.63%. For the Nono samples, GH has the highest colony of 49.9%, MA, followed by MA of 39.6% while the lowest is FA with 10.4%. The higher the no of colony, the more bacterial is present and the more chances that any consumers that will have problem when either the Fura or Nono is consumed. The calculation of the colony is the average sum total of dilution factor of 10^{-2} to 10^{-4} of the three samples purchased at each location. The dilution factor of 10^{-1} was not used because are too numerous to count. (TNTC)

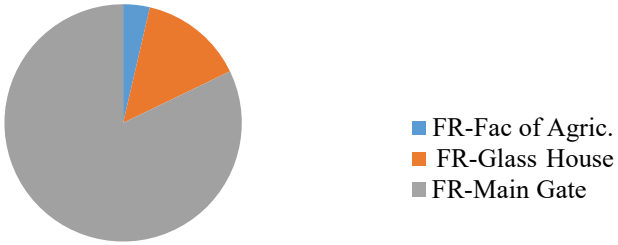

Fig.3.1a: Estimated bacterial colony of Fura (cfu/ml)

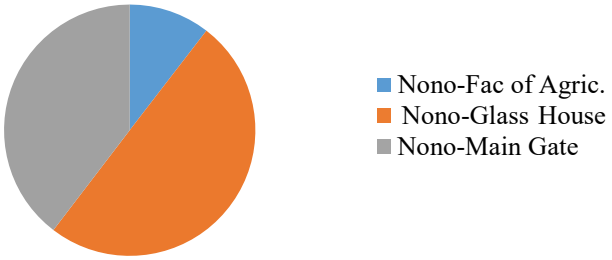

Fig.3.1b: Estimated bacterial colony of Nono (cfu/ml)

3.2.1. Gram staining tests

Gram stain is a method of staining used to classify bacteria into two large groups: gram-positive bacteria and gram-negative bacteria. It can also be used to diagnose fungal infections. (Gram Stain: *Medline Plus Medical Test". medlineplus.gov.)*. In microbiology, the staining is the most important and is the first step in identifying microorganisms. Gram-positive bacteria have thick cell walls because of thick layers of peptidoglycan, thus stain purple. In contrast, Gram-negative bacteria have thin layers of peptidoglycan and stain red/pink. Paray A.A. et.al 2023. Gram staining operates on the premise that the bacterial cell wall is capable of retaining the crystal violet dye during solvent treatment. The results of the gram staining tests in table 3.2.1a below show that the Fura samples FA and MG are gram positive with cocci and diplococci as a predominant bacterial, while the sample GH is gram negative with Baccili as a predominant bacterial. The Nono sample, The results of the gram staining tests in table 3.2.1b shows that Nono samples from both the FG and GH are gram negative with cocci and bacilli as a predominant bacterial, while the sample from MG are gram positive with diplococcic and cocci as predominant bacterial.

Table 3.2.1a: Grams staining of Fura (cfu/ml)

Sample ID	Gram's reaction	Microscopy
FR-FA-S1	Gram positive	Diplococci
FR-FA-S2	Gram positive	Diplococci
FR-FA-S3	Gram positive	Cocci in clusters
FR-GH-S1	Gram positive	Diplococci
FR-GH-S2	Gram negative	Bacilli in chain
FR-GH-S3	Gram negative	Bacilli in clusters
FR-MG-S1	Gram positive	Diplococci
FR-MG-S2	Gram positive	Cocci in clusters
FR-MG-S3	Gram negative	Cocci in clusters

Key: FR-FA-Fac. of Agric., FR-GH- Glass House, FR-MG-Main Gate

Table 3.2.1b: Grams staining of Nono (cfu/ml)

Sample ID	Gram's reaction	Microscopy
NO-FA-S1	Gram positive	Cocci in clusters
NO-FA-S2	Gram negative	Bacilli in chains
NO-FA-S3	Gram negative	Bacilli in clusters
NO-GH-S1	Gram positive	Diplococci
NO-GH-S2	Gram negative	Bacilli in clusters
NO-GH-S3	Gram negative	Bacilli in chains
NO-MG-S1	Gram positive	Diplococci
NO-MG-S2	Gram positive	Cocci in clusters
NO-MG-S3	Gram negative	Bacilli in chains

Key: FR-FA-Fac. of Agric., FR-GH- Glass House, FR-MG-Main Gate

3.3 .0 Bacterial Isolation

Bacterial isolation, purification and identification are the first steps to bacteriological studies. Isolation is done to obtain pure bacterial cultures. Ruangpan and Tendencia (2004). In the identification of bacteria and fungi, much weight is placed on how the organism grows in or on media. Colonies need to be well isolated from other colonies to observe the characteristic shape, size, color, surface appearance, and texture. In both Fura and Nono samples, tables 3.3.1a and 3.3.1 b respectively, five media was used for the characterization: Manihot Salt Agar (MSA), Eosine Methylene Blue (EMB), Salmonella Shigella Agar (SSA), Macconkey Agar and Xylos *Lysine Deoxycholate (*XLD). The suspected bacterial in both samples includes: Staphylococcus, E. Coli Klesiella spp, Salmonella spp, Pseudomonas spp, Shigella, Staphylococcus aureus, and Staphylococcus epidermis.

Table 3.3.1a Morphological appearance of bacterial on Fura colonies on differential and selective media

Sample ID	EMB	MSA	SSA	MCA	XLD	Susp. organism
FR-FA-S1	Green metallic sheen	Yellow colonies on mannitol fermenting	No growth of bacterial colonies observed	Round flat, colorless mucoid colonies	No growth of bacterial colonies observed	*E. coli, S. aureus, Pseudomonas spp*
FR-FA-S2	Green metallic sheen	Whitish mucoid colonies, non-mannitol fermenters	No growth of bacterial colonies observed	Round flat colorless colonies. Non lactose fermenters	No growth of bacterial colonies observed	*E. coli, S. epidermidis, shigella, pseudomonas spp*
FR-FA-S3	Green metallic sheen	Yellow colonies on mannitol fermenting	No growth of bacterial colonies observed	Round flat colorless colonies. Non	No growth of bacterial colonies observed	*E. coli, S. epidermidis, shigella, pseudomonas*

				lactose fermenters		*spp*
FR-GH-S1	Green metallic sheen	Whitish mucoid colonies Non mannitol fermenters	No growth of bacterial colonies observed	Round flat colorless colonies. Non lactose fermenters	No growth of bacterial colonies observed	*E. coli, S. epidermidis, shigella, pseudomonas spp*
FR-GH-S2	Green metallic sheen	Yellow colonies on mannitol fermenting	No growth of bacterial colonies observed	Large mucoid red colonies	No growth of bacterial colonies observed	*E. coli, S. aureus, Klebsiella spp*
FR-GH-S3	Green metallic sheen	Whitish mucoid colonies Non mannitol	No growth of bacterial colonies observed	Round flat colorless colonies. Non lactose	No growth of bacterial colonies observed	*E. coli, S. epidermidis, shigella, pseudomonas spp*
FR-MG-S1	Green metallic sheen	Whitish mucoid colonies Non mannitol fermenters	No growth of bacterial colonies observed	Round flat colorless colonies. Non lactose fermenters	No growth of bacterial colonies observed	*E. coli, S. epidermidis, shigella, pseudomonas spp*
FR-MG-S2	Green metallic sheen	Yellow colonies on mannitol fermenting	Smooth colorless colonies with black dots at the center	Round colorless colonies bw 2-3 mm	Black centered colonies red translucent zone	*E. coli, S. aureus, Salmonella spp*
FR-MG-S3	Green metallic sheen	Yellow colonies on mannitol fermenting	Green transparent colonies	Round flat colorless colonies. Non lactose fermenters	Pink flat red colonies	*E. coli, S. aureus, salmonella spp, shigella, pseudomonas spp*

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Table 3.3.1b Morphological appearance of Bacterial on Nono colonies on differential and selective media

Sample ID	EMB	MSA	SSA	MCA	XLD	Susp. organism
NO-FA-S1	Green metallic sheen	Yellow colonies on mannitol fermenting	Smooth colorless colonies with black dots at the center	Round colorless colonies bw 2-3 mm	Black centered colonies red translucent zone	*E. coli, S. aureus, Salmonella spp*
NO-FA-S2	Green metallic sheen	Yellow colonies on mannitol fermenting	Green transparent colonies	Round flat colorless colonies. Non lactose fermenters	Pink flat red colonies	*E. coli, S. aureus, salmonella spp, shigella, pseudomonas spp*
NO-FA-S3	Green metallic sheen	Whitish mucoid colonies, non mannitol fermenters	Smooth colorless colonies with black dots at the center	Round colorless colonies bw 2-3 mm	Black centered colonies red translucent zone	*E. coli, S. aureus, Salmonella spp*
NO-GH-S1	Green metallic sheen	Yellow colonies on mannitol fermenting	Green transparent colonies	Round flat colorless colonies. Non lactose fermenters	Pink flat red colonies	*E. coli, S. aureus, salmonella spp, shigella, pseudomonas spp*
NO-GH-S2	Green metallic sheen	Yellow colonies on mannitol fermenting	Green transparent colonies	Round flat colorless colonies. Non lactose fermenters	Pink flat red colonies	*E. coli, S. aureus, salmonella spp, shigella, pseudomonas spp*
NO-GH-S3	Green metallic sheen	Yellow colonies on mannitol fermenting	Smooth colorless colonies with black	Round colorless colonies between 2-	Black centered colonies red translucent	*E. coli, S. aureus, Salmonella spp*

			dots at the center	3 mm	zone	
NO-MG-S1	Green metallic sheen	Yellow colonies on mannitol fermenting	Smooth colorless colonies with black dots at the center	Round colorless colonies between 2-3 mm	Black centered colonies red translucent zone	*E. coli, S. aureus, Salmonella spp*
NO-MG-S2	Green metallic sheen	Yellow colonies on mannitol fermenting	Smooth colorless colonies with black dots at the center	Round colorless colonies between 2-3 mm	Black centered colonies red translucent zone	*E. coli, S. aureus, Salmonella spp*
NO-MG-S3	Green metallic sheen	Yellow colonies on mannitol fermenting	Green transparent colonies	Round flat colorless colonies. Non lactose fermenters	Pink flat red colonies	*E. coli, S. aureus, salmonella spp, shigella, pseudomonas spp*

3.4.0 Biochemical characterization of bacteria colonies

These are the tests that are performed on different bacterial for their identification on the basis of their biochemical activities towards different biochemical compounds. Eight different types of tests were used for the identification and the results are as shown below in tables. Ten different types of bacterial were identified in Fura and Nono samples, this include: *Entrebacter specie*, *Proteus Mirabis*, *Proteus Vulgaris*, *Shigella Specie*, *Salmonella typhi*, *Staphylococcus auereus*, *Escherichia coli*, *Klebsiella Pnuemoniae*, *Pseudomonas aeruginosa*, *staphylococcus epidermis* and *salmonella enteric* as shown in table 3.4.1a and 3.4.1b respectively.

Table 3.4.1a Biochemical Characterization of Nono

Sample ID	CAT	COT	OXT	CIT	UAT	INT	MRT	VPT	Organisms
NO-FA-S1	+	+	-	+	-	+	+	-	*S. aureus, E. coli, pseudomonas aeruginosa*
NO-FA-S2	+	+	-	-	-	+	-	+	*S.auresu, E. coli, pseudomonas aeruginosa, salmonella entrica*
NO-FA-S3	+	+	+	-	+	-	+	+	*S. epidermidis, E. coli, salmonella typhi, klebsiella pneumoniae, shigella specie*
NO-GH-S1	+	+	-	+	-	+	+	-	*S. aureus, E. coli, Enterobacter specie, proteus mirabilis*
NO-GH-S2	+	+	+	+	-	+	-	-	*S. epidermidis, E. coli, salmonella typhi, klebsiella pneumoniae, shigella specie*
NO-GH-S3	+	+	-	-	+	-	+	+	*S. aureus, E. coli, Salmonella typhi, proteus vulgaris, shigella*
NO-MG-S1	+	+	-	+	-	+	+	-	*S. aureus, E. coli, pseudomonas aeruginosa, klebsiella pneumoniae, Enterobacter specie*
NO-MG-S2	+	+	-	-	-	+	-	-	*S.auresu, E. coli, pseudomonas*
NO-MG-S3	+	+	+	-	-	-	+	-	*S. epidermidis, E. coli, proteus vulgaris, Enterobacter specie*

Key: CAT= catalase test, COT= Coagulase test, OXT=Oxidase test, CIT=citrate test, UAT= urea agar test, INT= indole test, MRT=methyl red test, VPT= vogesproskauer

NO-FA-S1	+	+	-	+	-	+	+	-	*S. aureus, E. coli, pseudomonas aeruginosa*
NO-FA-S2	+	+	-	-	-	+	-	+	*S.auresu, E. coli, pseudomonas aeruginosa, salmonella entrica*
NO-FA-S3	+	+	+	-	+	-	+	+	*S. epidermidis, E. coli, salmonella typhi, klebsiella pneumoniae, shigella specie*
NO-GH-S1	+	+	-	+	-	+	+	-	*S. aureus, E. coli, Enterobacter specie, proteus mirabilis*
NO-GH-S2	+	+	+	+	-	+	-	-	*S. epidermidis, E. coli, salmonella typhi, klebsiella pneumoniae, shigella specie*
NO-GH-S3	+	+	-	-	+	-	+	+	*S. aureus, E. coli, Salmonella typhi, proteus vulgaris, shigella*
NO-MG-S1	+	+	-	+	-	+	+	-	*S. aureus, E. coli, pseudomonas aeruginosa, klebsiella pneumoniae, Enterobacter specie*
NO-MG-S2	+	+	-	-	-	+	-	-	*S.auresu, E. coli, pseudomonas aeruginosa, salmonella typhi*
NO-MG-S3	+	+	+	-	-	-	+	-	*S. epidermidis, E. coli, proteus vulgaris, Enterobacter specie*

3.4.1b Biochemical Characterization of Fura

Sample ID	CAT	COT	OXT	CIT	UAT	INT	MRT	VPT	Organisms
FR-FA-S1	+	+	-	+	+	-	-	+	*S. aureus, E. coli, proteus vulgaris*
FR-FA-S2	+	+	-	+	+	+	+	-	*S.auresu, E. coli, Enterobacter specie*
FR-FA-S3	+	+	-	+	-	-	-	-	*S. epidermidis, E. coli, proteus mirabilis*
FR-GH-S1	+	+	-	-	-	+	-	+	*S. aureus, E. coli, klebsiella pneumoniae*
FR-GH-S2	+	+	+	+	-	-	+	+	*S. epidermidis, E. coli, salmonella enterica*
FR-GH-S3	+	+	-	+	+	-	-	-	*S. aureus, E. coli, proteus vulgaris,*
FR-MG-S1	+	+	-	+	-	+	+	-	*S. aureus, E. coli, pseudomonas aeruginosa, klebsiella pneumoniae, Enterobacter specie*
FR-MG-S2	+	+	-	-	-	+	-	-	*S.auresu, E. coli, pseudomonas aeruginosa*
FR-MG-S3	+	+	+	-	-	-	+	-	S. epidermidis, E. coli, proteus vulgaris, Enterobacter specie

Key: CAT= catalase test, COT= Coagulase test, OXT=Oxidase test, CIT=citrate test, UAT= urea agar test, INT= indole test, MRT=methyl red test, VPT= vogesproskauer

DISCUSSION

The result of these analyses shows that all samples were contaminated with bacteria, which are potential source of food borne infection and some related diseases to the consumers of this product in the sampling areas.

The bacteria isolated from the Nono samples include *Staphylococcus aureus* (15.38%), *Pseudomonas aeruginosa* and *Salmonella typhi* (10.25%), *Escherichia coli* (23.1%), *Salmonella epidermidis, Enterobacter specie, Klebsiella pneumonia* and *Shigella specie* 7.69%, Proteus *vulgaris* 5.13%, *Proteus mirabilis* and *Salmonella entrica* 2.56%.

The bacteria isolated from the Fura include *Escherichia coli* 31.03%, *Staphylococcus aureus* 20.69%, *Enterobacter specie* and *Salmonella epidermidis* 10.34%, *Klebsiella pneumoniae*, and *Pseudomonas aeruginosa* 5.13%, *Proteus mirabilis* and *Salmonella entrica* 3.45%.

In both samples, Fura and Nono, the predominant bacterial are: *Escherichia coli, Staphylococcus aureus, Pseudomonas aeruginosa, Salmonella typhi, Enterobacter specie* and *Salmonella epidermidis* which account for more than 70% of the bacterial.

Owusu-Kwarteng et al., 2010 carried out a research on bacterial isolated from Fura by local vendor

in Federal University, Wukari, it was discovered that *Staphylococcus aureus* as the predominant organisms accounting for 35.8% followed by Staphylococcus spp 34%, *Streptococcus spp* 32%, *Pseudomonas aeruginosa* 21.8%, *Escherichia coli* 15.3% *Klebsiella spp* 14.2%, *Bacillus spp* 13.9%. This is similar to the result of the present study carried out in Federal University Gashua This preponderance of *Staphylococcus aureus* is in agreement with other studies, which may be due to the organisms been part of the normal flora of the skin and can easily contaminate locally made Fura and Nono. According to Taylor & Unakal (2019), *Staphylococcus aureus* is a Gram-positive bacteria that often habour the skin and mucous membranes of animals and humans. It also has the ability to multiply quickly at room temperature to produce toxins that cause illness. *Escherichia coli* is another bacterial isolated from both the Fura and Nono, the Fura contamination may be as a result of unhygienic way it was prepared handling and marketing. Gözde Ekici and Emek Dümen (2019) asserted that most important sources of contamination for these groups of microorganisms are reported as: areas with unfavorable hygiene, contaminated waste water, meat products, cereal products and vegetables. The *E. coli* in Nono is principally due to its abundance in cattle's gastrointestinal tract (GIT). Though most of the *E. coli* strains found within the GIT are commensals, there are some pathogenic species causing human diseases (such as enteritis) Kumar and Prasad (2010).

The result also corroborates with the report of Maikai and Madaki (2018) who isolated similar organisms such as *Enterobacter*, *Proteus*, *Klebsiella* and *Citrobacter species* from 'nono' in Samaru, Kaduna, Nigeria and the work of Bazata et al. (2020) who isolated *Staphylococcus aureus*, *Salmonella spp*, *Lactobacillus plantarum* and *Escherichia coli*. The presence of *Salmonella* and *Shigella* (7.69%) species agrees with the work of Esonu et al., (2021) which could be due to the level of hygienic practices in the area of study and the lack of potable water used in the production processes. The use of water from the ponds that are not well maintained maybe one of the reasons for this contamination.

CONCLUSION

The result of the two samples analyzed shows that all the samples were contaminated with bacteria, some with more than two or three, these are potential source of food borne infection and some related diseases to the consumers of this product in the sampling areas. The bacteria isolated include *Entrebacter specie*, *Proteus Mirabis*, *Proteus Vulgaris*, *Shigella Specie*, *Salmonella typhi*, *Staphylococcus auereus*, *Escherichia coli*, *Klebsiella Pnuemoniae*, *Pseudomonas aeruginosa*, *staphylococcus epidermis* and *salmonella enteric*. The predominant bacterial are *Staphylococcus auereus* and *Escherichia coli*, this may be attributed to lack of effective sanitary precautions and less careful handling procedures during milking process and nono production. The use of traditional milking methods also exposes milk to pathogenic bacteria found in cow udders and probably on the hands of the milkers who may have come in contact with faeces of the cows or that of their young children. The unhygienic environmental conditions where fura and nono is marketed may have also contributed to its contamination as most of the other bacteria are also spread through person-to-person contact and by contamination in the environment.

RECOMMENDATIONS

Fura and Nono is one of the food that serves as lunch for both staff and students of Federal University, Gashua.

- It is recommended that foods sold in the campus by the vendors be subjected to microbiological examination periodically so as to assess their suitability for consumption.
- The Fura and Nono vendors should be more educated as to understand the basic concept of hygiene and handling.
- Processing and packaging of Fura and Nono should be carried out under hygienic environment to avoid contamination.
- Avoid milking unhealthy cows.
- Adequate heating process should be employed where applicable.
- Department of Home Science and Management may involve in the preparation and selling of the Fura and Nono

REFERENCES

Egwaikhide P.A., Malu, P.S., Lawal U., Adelagun R.O., and Andrew, C. (2014) Physico-chemical and microbiological analysis of fermented cow milk (Nono) consumed within Kaduna town, North West Nigeria. *Journal of Food Science and Quality Management*; 29; 44-49

Ekici, G. & Dümen, E. (2019). Escherichia coli and Food Safety. The Universe of Escherichia coli 10.5772/intechopen.82375

Esonu, D. O., Ismail, S., Ajala, A., Yusuf, S. M. & Otolorin, R. G. (2021). Occurrence and antimicrobial susceptibility patterns of staphylococcus aureus and salmonella species in fresh milk and milk products sold in Zaria and environs, Kaduna State, Nigeria. *Sahel Journal of Veterinary Sciences*, 18(2), 1-8.

Gemachu T, Beyene F, & Eshetu M. (2015). Physical and chemical quality of raw cow's milk produced and marketed in Shashemene Town, Southern Ethiopia. *Journal of Food and Agriculture Science*. *5*(2):7-13.

Kumar, R., & Prasad, A., (2010). Detection of *E. coli* and *Staphylococcus* in milk and milk products in and around Pantagar. *Pakistan Journal of Nutrition*. *1,* 151-152.

Kwarteng, J. O., Akabanda, F., Nielsen D.S., Tano-Debrah K., Glover L.K., & Jespersen L. (2012). Identification of lactic acid bacteria isolated during traditional fura processing in Ghana. *Journal of food microbiology*. 32(1):72-8

Maud, K. J. (1990). Processing and preservation of tropical foods and sub-tropical foods FAO 112 - 144.

Maikai, B. V. & Madaki, P. D. (2018). Enumeration of coliforms in fermented milk product (nono) sold in Samaru, Kaduna State, Nigeria. Sokoto. *Journal of Veterinary Sciences, 16*(4), 50-57.

Paray A.A., Singh M., Mir M. A., & Kaur A. (2023). Gram Staining: A Brief Review *International Journal of Research and Review 10*(09):336-341.

Ruangpan, L., & Tendencia, E. A. (2004). Bacterial isolation, identification and storage. In *Laboratory manual of standardized methods for antimicrobial sensitivity tests for bacteria isolated from aquatic animals and environment* (pp. 3–11). Tigbauan, Iloilo, Philippines: Aquaculture Department, Southeast Asian Fisheries Development Center.

Taylor, T. A., & Unakal, C. G. (2019). *Staphylococcus aureus.* Treasure Island (FL): Stat Pearls Publishing.