International Journal of Food Nutrition and Safety, 2024, 15(1): 22-36

Modern Scientific Press

International Journal of Food Nutrition and Safety **ISSN: 2165-896X**

Journal homepage: www.ModernScientificPress.com/Journals/IJFNS.aspx *Florida, USA*

Article

Bacteriological Safety of Some Traditional Dairy Products in Selected Local Government Areas of Zamfara State, Nigeria

Mohammed Ibrahim Ribah* and Abdullahi Umar

Department of Animal Science, Faculty of Agriculture, Kebbi State University of Science and Technology, Aliero, PMB 1144, Birnin Kebbi, Kebbi State, Nigeria

*Author to whom correspondence should be addressed: ibrahim.ribah73@gmail.com

Article history: Received 16 November 2023, Revised 25 January 2024, Accepted 29 January 2024, Published 3 February 2024.

Abstract: This study assessed the bacteriological safety of fresh milk, fermented milk and butter in Talata Mafara, Maradun and Bakura local government areas, Zamfara state. A total of thirty (30) milk samples were collected under optimum hygienic conditions and subjected to standard microbiological analysis. Biochemical tests were conducted to identify bacteria present in the samples. Bacterial counts from the samples were interpreted and expressed as cfu/ml. Results of total bacterial count indicated that there was no significant differences (P>0.05) between the milk products as far as bacterial load is concerned. However, bacterial load showed that Fresh milk had higher log ($21.43x10^{-5}$) followed by fermented milk log ($17.10x10^{-5}$) and butter had the least bacterial load with log ($11.54x10^{-5}$). The prevalence results indicated that fifty six (56) bacteria isolates were isolated and identified from all milk products samples. The most prevalence bacteria were *Staphylococcus aureus* (23.2%), *Bacillus lentus* (16.1%), *Bacillus subtilis and Bacillus megaterium* with 10.7% each and *Escherichia coli* (7.1%). It was concluded that the presence of *Escherichia coli* and *Staphylococcus aureus* is an indication that there could be risk of consuming milk from the study area due to hygiene issues and that personnel hygiene practices in milk production in the study area was insufficient.

Keywords: Bacteriological, Safety, Traditional, Dairy Products

1. Introduction

Milk is the most common source of the nutrients required to human body especially in the rural communities. Milk and its products are main components of the Nigerian economy, about 90 percent of cattle producing milk belong to the agricultural pastoralist Fulani, and their women process and sell the milk, (Fakayode *et al.* 2012). In Africa, consumption of milk and milk products will continue to increase from their current levels as a result of population increase, economic growth, and urbanization (Tschirley *et al.* 2014). Improper processing, pasteurized and storage of milk can lead to spoilage and proliferation of large number of pathogens which are responsible for Brucellosis, Tuberculosis, Listeriosisetc, (Luminos *et al.* 2007). As a result of their highly nutritious nature, they facilitate the proliferation of many microorganisms, including disease causing bacteria, (Pal *et al.* 2016). This can pose a threat in the health of people globally especially in developing countries such as Nigeria, (Luminos *et al.* 2007). Under poor sanitary conditions, milk can easily be contaminated by several bacteria (Prajapat 1995).This entails the importance of having the knowledge of the hazards that cause food-borne diseases and the risks associated with the hazards which will enable nations through their agencies to significantly reduce the problem, (Chatterjee *et al.* 2006).

Milk can gradually deteriorate as a result of microbial contamination which could lead to total spoilage and cause milk-borne diseases to the consumers (Addo *et al.* 2011; Ngasala *et al.* 2015; Mpatswenumugabo *et al*., 2019). These diseases can seriously injure the health of anyone who drinks contaminated raw milk or eats products made from contaminated raw milk. Several approaches had been devised to minimize the possibilities of microbial contamination of milk and milk products. Some approaches include improving animal health, hygiene of the milk handler, prope sanitation of containers, transportation facilities, cooling and pasteurization of raw milk and various dairy products (Lore *et al.* 2005). Achieving these approaches may however be challenging in developing countries where there is inadequate dairy infrastructure. Consequently, because milk is a wholesome food of high nutritive value, it is often susceptible to early contamination and spoilage in the absence of proper handling practices (Mahari and Yemane, 2016). Several researchers have reported that milk is an ideal growth medium for microorganisms (Ali and Abdelgadir, 2011).

Consumption of unpasteurized milk is still common in most parts of Nigeria predisposing consumers to food-borne diseases. Food borne infections have been identified as an important public health and economic problem in developed as well as developing countries. Consequently, microbial food safety has forth come as a significant global issue for the consumer, industry, researcher, and regulatory bodies. The microbial contamination is one of the leading causes of food spoilage worldwide, (Pal 2014).

The possibility of the microbial pathogens and others problems associated in the informal milk processing in Nigeria is unknown to many people of the risk to human health, and current food safety management is not affective. Food is one of the most important transmission routes of diseases globally due to microbial contaminations, (Odeyemi *et al.* 2016). Consumption of food contaminated with food borne pathogens and microbial, such as toxins could result in serious illnesses and economic loses, (Pires *et al*. 2009 and Ben *et al.* 2013). Some of the microbial contaminants are responsible for milk spoilage while others are pathogenic with potential health effects which cause milk– borne diseases, (Oliver *et al.* 2009). Bacterial contamination of milk may occur mainly through cow' s *microflora*, improper udder washing, breast infection, milking and milking conditions, and equipment for handling and storage facilities, (Sarkar 2016). This research was to isolate the microbial safety of milk and identify the prevalence of bacteria in milk, in the traditional dairy products in the study area.

2. Materials and Methods

2.1. Description of the Study Area

The research was carried out in three (3) selected local government areas of Zamfara state, (Talata Mafara, Bakura, and Maradun local governments).in northwestern Nigeria. Its coordinates are 12°10'0" N and 6°15'0" E. Agriculture, and gold mining are the main occupations of the people of the state and the central source of incomes. Zamfara state has total area of 38,418 km^2; it is bordered in the North by Niger republic, to the South by Kaduna State. In the east, it is bordered by Katsina State and to the West by Sokoto and Niger States. It has a population of 3,278,873 according to the 2006 census, and contains fourteen local government areas; Zamfara has the tropical savanna climate**,** NPCR (2017). Zamfara region is chosen for the study due to its long history of livestock keeping and dairy marketing.

2.2. Instruments

The instruments and equipment used in this study include glassware, autoclaves, centrifuges, laminar flow hoods, biosafety cabinets, incubators, refrigerators, microscopes, petri , dishes, burnsen burners, desiccator, ager plates, culture, bottles, analytical balance, digital scale, colony counter, homogenizer, hot plates, tirrers, vortex mixer, water distiller, ovens, loops and needles, general and selective culture media and chemicals.

2.3. Sample Size

A total of thirty (30) samples including Fermented milk, Fresh milk and Butter were collected under optimum hygienic condition, using new sterilized syringes, and handled with disposable hand gloves as indicated in Table 1. The samples were taken to the laboratory for bacteriological analysis.

Table 1: Sampling and sample size of milk products

Type of milk	Source	No. of samples
Fermented milk	traditional dairy farmers	10
Fresh milk	traditional dairy farmers	10
Butter milk	traditional dairy farmers	10
TOTAL		**30**

2.4. Serial Dilutions

Five (5) test tubes were used for serial dilutions, a nine ml (9ml) of distilled water was dispensed in to test tubes, fifth-fold serial dilution of the sample from 10^{-1} to 10^{-5} than autoclaved at 121 ^{o}C and allowed for 15 minutes. After autoclaving it was then allowed to cool for at least 45 ^{o}C and then 1 lm of the milk sample was dispensed in a sterile test tube containing 9 ml of distilled water. In the first test tube the sample were been mixed homogenously. A 5 syringes were used to serially dilute the sample to the last test tube, and that is the sample methods of serial dilution applied to the whole samples respectively.

2.5. Media Preparation

Different media were prepared for this research used for culture, subcultures and biochemical test, these media includes:

2.5.1. Nutrient agar

A nutrient Agar were prepared by dissolving 28g of powdered Nutrient Agar in to 1000ml of distilled water according to the manufacturer instruction and heat to dissolved in conical flack and autoclaved at 121 ^{o}C plus 15 minutes and allowed to cool down to 45 ^{o}C before pouring into a sterile Petri dish.

2.5.2 MRVP broth

Seventeen grams (17g) of the MR-VP broth was dissolved in 1000ml of distilled water and heated to dissolved on hot plate and dispensed in a test tube and autoclaved at 121 ^{o}C plus 15 minutes and allowed to cool down to 45 ^{o}C.

2.5.3. Urea agar base

Twenty four grams (24g) of powdered urea agar base was dissolved 990ml of distilled water and dispensed in a slant bottles based on the manufacturer instruction and autoclaved at 121 ^{o}C plus 15 minutes than allowed to cool down to 45 ^{o}C after autoclaved 0.1ml of 20% sterile urea-salt was added in each slant bottles containing the urea agar base when it cool to 45 ^{o}C and put the bottles in slant position to solidified.

2.5.4. Simon citrate agar

A 24g of simon citrate agar was dissolved in 1000ml of distilled water, based on the manufacturer instruction and heated to dissolved in the conical flask and 10mls would be dispensed in a test tube covered with cotton wool and aluminum fuel, than autoclaved at 121 ^{o}C plus 15 minutes to achieved sterility than allowed to cool at 45 ^{o}C (Cheesebrough 2002).

2.5.5. Triple sugar ion Agar (TSI)

A 65g of TSI Agar was dissolved in 1000mls of distilled water and heated to get homogeneous mixture, and dispensed in a test tube and covered with cotton wool, it was than autoclaved at 121 ^{o}C plus 15 minutes, after autoclaving it was the placed in slant position for solidification.

2.5.6. Indole (Tryptophan broth)

A gram of tryptophan was dissolved in 1000mls of distilled water and heated to dissolved and dispensed in a test tube for autoclaving, after autoclaving it was removed and allowed to cool at 45 ^{o}C than inoculated it.

2.5.7. Starch hydrolysis

A 10% of starch Nutrient agar was prepared in conical flask and dissolved in distilled water, than heated on hot plate and autoclaved in conical flask after autoclaving it was than dispensed in a sterile Petri dish, (Manga and Oyeleke 2008).

2.6. Sample Inoculation

Using a sterile syringe 0.1 ml for the serial dilution, samples from the test tube 10^{-4} and 10^{-5} were inoculated in two different Petri dish contained nutrient agar respectively using spread method and inoculated for 24 hrs at 30 ^{o}C for growth of microorganisms.

2.6.1. Subculture

Four (24) hours old bacterial growth was appeared on the nutrient agar plates, the morphological characteristics of the bacterial colony was used for subculture, this was taken placed on a sterile nutrient agar plate by striking methods.

2.6.2. Gram staining

A smear of 24 hours old subculture bacteria was fixed on graces free glass slide by picking a loopfull colony with wire loop and fixed on a drop of water on the glass slide and emulsified than heat fixed. A dried smear was flooded with crystal violet for 60 sec. and wash with water dying with Lugol iodine for another 60/sec. the decolorized with metheyleted spirit and counter stained with Safranine for 60 seconds and allowed to dry for microcopy.

2.6.3. Microscopy

A gram stained slide was placed on a stage of the microscope X40 objective lens was used to view the background of the gram stained and smear and latter X100 objective lens was used with oil emersion to view the image, (Cheesebrough, 2002).

2.7. Biochemical Test

Sugar fermentation Lactose, Sucrose, Glucose test was carried out in TSI agar by inoculating 24 hrs old culture in a slanted test tube and incubated at 37 ^{o}C for 24 hrs, acidic reaction that resulted the formation of yellow color of both, But and slant shows that the organism fermented the whole Sugar. When only turned to yellow and the slant are pink. The pink color shows alkaline reaction and therefore the bacteria can only ferment glucose.

2.7.1. Mortility

A speck of each was stabbed into the TSI agar using inoculation needle. The medium was than inoculated at 37 ^{o}C for24 hrs, a little spread in the streaking inoculated mortality positive absence of that is indicated negative, (Cheesbrogh, 2002).

2.7.2. Methyl red test

A 24 hrs old culture inoculated in a sterile mr vp medium test tube and inoculated at 37 ^{o}C for 24 hrs after inoculation 3 drops of methyl red indicator was added change to red color on addition signifies a positive result while yellow color signifies a negative result.

2.7.3. Voges-proskauer test

Five (5) drops of 40% KOH will be added followed by 1 drop of Naphol in ethanol is added, shaken and placed in a sloping position red color starting of the liquid within one hour indicated positive VP while no change indicated negative, (Oyeleke and Manga 2008).

2.7.4. Indole test

A 24 hrs old culture in tryptophan was added with 2 drops of COVACS reagent and gating shacked a positive color indicated by the development of a red color in the reagent layer above the broth within a minute, (Oyeleke and Manga 2008).

2.7.5. Urea test

A prepared slants bottle of urea agar base was inoculated with test isolate and inoculated at 37 ^{o}C for 72 hrs. The development of a bright pink or red color indicated a positive result, (Oyeleke and Manga 2008).

2.7.6. Catalase test

A 2-3 ml of the hydrogen peroxide solution were be poured into a test tube, A sterile Swab stick were used to remove several colonies of the test isolates and immersed into the hydrogen peroxide solution. Immediate bubbling was indicated catalase positive, (Cheesebrogh 2002).

2.7.7. Gas test

A test tube containing slanted TSI media were inoculated within 24 hrs old culture of the test isolate and incubated at 37 ^{o}C for 24 hrs, the presence of air bubbles or cracking of the medium indicated gas positive, (Cheesebrough 2008).

2.7.8. Hydrogen sulphade test

A test tube of slanted TSI was inoculated within 24 hrs old culture of the test isolated and inoculated for 24 hrs at 37 ^{o}C the production of hydrogen sulphade was deflected by the blackening of the media.

2.8. Data Analysis

The collected data was entered in to Microsoft Excel, (2013) and analyzed through Statistical Package for Social Sciences (SPSS). Bacterial counts from the samples were interpreted and expressed as cfu/ml. Relationship between different practices as risk factors for microbial safety in milk were compute against Total plate count (TPC) statistical significance established at 5% confidence.

3. Results and Discussion

3.1. Bacterial load of milk and milk products isolated from samples in TalataMafara, Bakura and Maradun Local Government Areas, Zamfara State

Result for bacteriological load of milk and milk products isolated from samples in the study areas are presented in Table 2. Results of total bacterial count (TBC) indicated that there is no significant difference ($P<0.05$) between the milk products as far as bacterial load is concerned. However, Fresh milk was found to have higher log ($21.43x10^{-5}$) followed by fermented milk log ($17.10x10^{-5}$) and butter had the least bacterial load with log ($11.54x10^{-5}$). However, all the microbial load of the milk products falls outside USDA satisfactory limits for bacterial load in milk and milk products.

Table 2: Bacterial loads of milk and milk products isolated from samples in the study areas

TREATMENT	PLATE COUNT (cfu/g) Dilution factor 10^{-4}	10^{-5}	Total	Mean	Cfu/ml	USDA RANGE
Fermented Milk	285.58	56.50	342.08	171.04	17.10×10^{-5}	unsatisfactory
Fresh Milk	379.41	49.16	428.58	214.29	21.43×10^{-5}	unsatisfactory
Milk Butter	199.83	31.00	230.83	115.41	11.541×10^{-5}	unsatisfactory
SE	54.52	14.04	51.33	25.66		

3.2. Biochemical Characteristics and Identification of Bacteria Isolates from Fresh Milk, Fermented Milk and Butter Collected from Maradun, Bakura, and TalataMafara Local Government Areas, Zamfara State

Results for biochemical characteristics and identification of bacteria isolates from fresh milk, fermented milk and butter collected from the study area are presented in Table 3. Result shows that, out of the thirty (30) fresh milk samples collected from the study are, seventeen (17) samples were found to be contaminated with some bacteria. Twelve (12) bacteria isolates identified from fresh milk samples include *Escherichiacoli*(1), *Staphylococcus aureus*(5), *Klebsiellapneumoniae*(2), *Shigella spp.* (1), *Bacillus megaterium* (2), *Bacillus subtilis*(1), *Proteus bulgaris*(1), *Proteus mirobillis*(1), *Bacillus*

lentus(1),*Lactobacillus fermentus* (1), *and Bacillus firmus* (1). Thirty (30) fermented milk samples were collected from the study area, twenty samples were found to be contaminated with sometwenty four (24) bacteria. The twenty four (24) bacteria isolates identified from Fermented milk samples include *Staphylococcus aureus* (6), *Lacto B. planetarium* (2), *Lacto B. fermentium* (1), *Escherichia coli*(1), *Bacillus subtilis*(4), *Bacillus megaterium* (1), *Bacillus lentus* (5), *Bacillus femilus* (1) and *Bacillus cereus* (3). Out of the thirty (30)butter samples collected from the study area, twenty two (22) samples were found to be contaminated with some eighteen (18) bacteria including *Staphylococcus aureus*(2). *Proteus bulgaris*(2), *Lactobacillus plantarium*(2), *Escherichia coli*(2), *Bacillus pumilus*(2), *Bacillus lentus*(3), *Bacillus subtilus*(1) and *Bacillus megaterium* (3). Generally, *Staphylococcus aureus*was found to be more prevalent in thetotal milk samples collected. The presence of *Escherichia coli* which is a hygiene indicator, bacteria is an indication that there could be risk of consuming milk from the study area due to hygiene issues.

3.3. Prevalence of Bacteria Isolates from Fresh Milk, Fermented Milk and Butter Collected from Maradun, Bakura, and Talata Mafara Local Government Areas, Zamfara State

Results for prevalence of bacteria isolates from fresh milk, fermented milk and butter collected from Maradun, Bakura, and Talata Mafara Local Government Areas, Zamfara State are presented in Table 3. Results indicated that fifty six (56) bacteria isolates were isolated and identified from all milk products samples. *Staphylococcus aureus*was found to be more prevalent accounting for (23.2%) of the bacterial population isolated and was followed by *Bacillus lentus*(16.1%), *Bacillus subtilis* and *Bacillus megaterium* with 10.7% each. The presence of *Escherichia coli* (7.1%) which is a hygiene indicator bacteria, is an indication that there could be risk of consuming milk from the study area due to hygiene issues.

Table 3: Prevalence of Bacteria Isolates from Fresh, Fermented and Butter Milk samples Collected from Maradun, Bakura, and TalataMafara Local Government Areas, Zamfara State

Bacteria Isolated	**Prevalence**	
	Frequency	Percentage
Staphylococcus aureus	13	23.2
Bacillus lentus	9	16.1
Bacillus subtilis	6	10.7
Bacillus megaterium	6	10.7

Lactobacillus planetarium	4	7.1
Escherichia coli	4	7.1
Proteus bulgaris	3	5.4
Bacillus cereus	3	5.4
Lactobacillus fermentium	2	3.6
Klebsiella pneumoniae	2	3.6
Bacillus pemulus	2	3.6
Bacillus firmilus	2	3.6
Shigella sspp	1	1.8
Proteus mirobillis	1	1.8
Total	**56**	

Fresh milk was found to have higher log ($21.43x10^{-5}$) followed by fermented milk log ($17.10x10^{-5}$) and butter had the least bacterial load with log ($11.54x10^{-5}$). However, all the microbial load of the milk products falls outside USDA satisfactory limits for bacterial load in milk and milk products. This finding is corroborated with that of (Umofia *et al.* 2014). The high total aerobic bacteria counts in the milk products examined could be a consequence of the low-level of hygiene maintained during the processing of the milk products.

Prevalence of bacterial pathogens isolated in milk handling practice and bacterial safety in the present study is instigated and requires alertness in the traditional dairy industry. The microbiological quality of dairy products reflects good hygienic practices during the dairy milking process; raw milk contamination may occur in diseased or infected cows with environmental bacteria, (Kongo *et al*. 2008). The identified bacterial in this study are *Staphylococcus aurous (23.2%), Bacillus lentus (16.1%), Bacillus subtilis (10.7%), Bacillus megaterium (10.7%), Lactbacillus planetarium (7.1%) Escherichia coli (7.1%) Proteus bulgaris (5.4%), Bacillus cereus(5.4%),Lactobacillus fermentium (3.6%), Klebsiella pneumonia (3.6%), Bacillus pemulus(3.6%), Bacillus firmilus (3.6%), Shigella spp. (1.8%), and Proteus mirabilis (1.8%).*

Therefore the Present of those microorganisms from the result obtained in the studied milk samples indicated that there are serious public health problem as some (organisms) were to be human pathogens (*Staphylococcus aureus* in milk). *Staphylococcus aureus* are a facultative anaerobic**,** Gram-

positive *coccus,* which appears asgrape-like clusters when viewed through a microscope and has large, round, golden yellow colonies, often with haemolysis, when grown on blood agar plates, (Ryan and Ray 2004). Farmers milked their animals from unsanitary environments predisposing milk to contamination and deterioration.

This finding expected to have a regular sanitary practices and majority of the respondents were not followed, which might resulted the present of *Bacillus spp.* in the samples collected from the study area. The evidence of dairy environmental contamination was attributed to *Bacillus* strains during the technological processing of milk. Moreover, *Bacillus* cereus has been linked to food poison, (Gopal *et al.* 2015). (Banyko *et al.* 2009) also reported that maintaining the sanitary condition of milking area is important prerequisite for clean milk production.

The presence of *Bacillus spp.* in raw milk might emanate from various sources; soil, milking container, air and food source, (Velazquez *et al.* 2019). (Matofari *et al*. 2013) reported that as the food goes to many handlers the risk of poising the food to unhygienic environment, contamination, and adulteration increase. Current result, is emanate to result of (Attah *et al.* 2021) in Niger, Nigeria, whose identified corroborated bacterial from his studied area, *Bacillus spp*., *Escherichia coli*, *Salmenella typhi*, *Staphyloccocus aureus* and *Staphylococcus epidermidis* had been revealed through Gram reaction and biochemical results that some were positive while others were negative to the various test carried out. *Staphylococcus aureus* has been reported highly vulnerable to destruction by heat treatment and nearly all sanitizing agents. The presence of this bacterium in milk is an indication of poor sanitation during processing, handling and packaging or post pasteurization contamination, (Ahmed *et al*. 2011).

Staphylococcus aurous is a Gram-positive bacterium, it founded in a higher percentage in this study, and usually causes mastitis in cows and other domestic dairy ruminants. Also Result of (Hahn 1996) revealed that present of *E. coli* could be due to faecal contaminated water used in milk production and raw materials storage environment. *E. coli* is a ubiquitous organism, and pathogenic strains if present could be harmful to consumers. The prevalence of *Escherichia coli* in this study is significant (7.1%) which is even lower than (Ali and Abdelgadir 2011) and (Lingathurai and Vellathurai 2010) respectively, reported higher prevalence values of *E. coli* (60% and 70%). (Crump *et al. 2002)* reported 13% prevalence of *E. coli* in raw milk of his finding. *E. coli* could generate from milk handler s to the processing of the milk and its products. (Frank *et al.* 1984) represents a health hazard and should be considered important because of the recent considerations of animal as a source of *E. coli* that are pathogenic to man. Also recent result had support, (Newell *et al.* 2010) the common raw milk pathogenic bacteria contaminants include: *Brucella abortus,* Shiga toxin producing *E. coli, Staphylococcus aurous, Salmonella* spp., and *Clostridium* spp.

4. Conclusions

The study concluded that total bacterial count (TBC) from all the milk products as far as bacterial load is concerned falls outside USDA satisfactory limits for bacterial load in milk and milk products, indicating high risk to consumers and public health most especially by detection of *Staphylococcus aureus, E. coli* and *Brucella spp*.

References

Addo K. Mensah KGI. Aning KG. (2011). Microbiological quality and antibiotic residues in informal marketed raw cow milk within the coastal savannah zone of Ghana," *Tropical medicine and international Health*, (2): 227-232.

Ahmad N., Ubaid-ur-Rahman A. Malik LA. Safeer P. and Ubaidullah M. (2011). *Contamination of raw milk with Escherichia coli sold in Peshawar University Campus and adjacent area, Pakistan*. 3(2): 72-75.

Ali AA. Abdelgadir WS. (2011). Incidence of *Escherichia coli* in raw cow's milk in Khartoum state. *British Journal of. Dairy Sciences*, 2(1): 23-26.

Attah, F. Abalaka M. E. Jesse, I. A. Garba D. E. and Emmanuel A. (2021). Bacteriological Quality of Raw Cow' s Milk Sold in Minna Central Market, Niger State, Nigeria, *International Journal of Pathogen Research*, 6(1): 29-35.

Amanuel Teklehaymanot Mahari, A.T., Haftom Yemane, H. (2016). Cow Milk Handling Practices and Factors Contributing to Quality Deterioration in Ethiopia. *Food Science and Quality Management*, 16: 48

Banykó, J. Vyletelová M. (2009). Determining the source of *Bacillus cereus* and *Bacillus licheniformis* isolated from raw milk, pasteurized milk and yoghurt. *Letters in Applied Microbiology*. 48(3): 318-323.

Ben, A. S. Ainsley M. O. Aamir M. F. Greg M. P. Anna M. L. (2013). *Microbial food safety risk assessment in Compendium of methods for the microbiological examination of foods*. In: eds. Downes F.P., Ito K, eds. American Public Health Association. pp. 1-369

Chatterjee, S. Bhattacharjee I. S. Chatterjee K. and Chandra G. (2006). Microbiological examination of milk in Tarakeswar, India with special reference to coliforms. *African Journal of Biotechnology*, (5): 1383-1385.

Cheesebrogh M. (2008). *District practical in tropical countries, part two*, 3rd edition Cambridge university press, Cambridge England, pp. 62-70.

Cheesebrogh M. (2002) *District practice in tropical countries, part two*, 2nd edition Cambridge university Press, Cambridge England. 12-20.

Crump J. A. Sulka A. C. and Langer A. J. (2002). An outbreak of *E.coli* O157:H7 infections among visitors to a dairy farm. *New England Journal of Medicine (*347): 555-60.

Dadi, S. Lakew M. Seid M. Koran T. Olani A. Yimesgen L. (2020). Isolation of Salmonella and E. coli (E. coli O157:H7) and its Antimicrobial Resistance Pattern from Bulk Tank Raw Milk in Sebeta Town, Ethiopia. *HSOA JVAR*, 4(21): 1-7.

Dinges, M. M. Orwin P. M. and Schlievert P. M. (2000). Exotoxins of *Staphylococcus*

Fakayode, S. B. Olorunsanya E. O. Nwauwa L.O.E. Yusuf T. M. and Oyeleye O. O. (2012). Economics of local cow milk products marketing in kwara State, Nigeria. *JAFS*. 10(1).

Frank, V. Hahn G. and Tolle A. (1984). Incidence and identification of enterotoxigenic *Escherichia coli* strains in milk and milk products. *Bacteriology Microbiological Hygiene*, (257):51-59.

Gopal, N. Hill C. Ross P.R. Beresford T. P. Fenelon M. A. Cotter P. D. (2015). The prevalence and control of Bacillus and related spore-forming bacteria in the dairy industry. *Front. Microbiol*. (6):1418.

Hahn G. (1996). Pathogenic bacteria in raw milk situation and significance. In: Bacteriological quality J. Dairy Sci., of raw milk. Brussels (Belgium), *International Dairy Federation*: 67-83.

Kongo, J. M. Gomes A. P. and Malcata F. X. (2008). Monitoring and identification of bacteria associated with safety concerns in the manufacture of São Jorge, a Portuguese traditional cheese from raw cow's milk. *Journal of Food Protection*, 71(5):986-992.

Lingathurai, S. and Vellathurai P. (2010). Bacteriological Quality and Safety of Raw Cow Milk in Madurai, South India. *http://www.webmedcentral.com/article_view/1029*

Lore, T. Omore A. Steal S. (2005). Types, levels and cause of post harvest milk and dairy losses in sub-Sahara Africa and the Near East: phase two synthesis report Nairobi. At: htt://cgspace.cgar.org/bitstream/handle/10568/3741/phase2PFLsynthesisreport.pdf?sequence=1

Luminos, M. Jugulete G. Iagăru R. Mantescu R. Matei R. Zamfir A. (2007). Listeria the enemy from the freezer. *Therapeutics, Pharmacology and Clinical Toxicology*. I(2).

Maikai, B. V., and Maidaki P. D. (2018). Enumeration of coliform in fermented milk product (non) sold in Samaru, Kaduna State, Nigeria. *Sokoto journal of veterinary science*, 16(4): 50-57.

Mahari TA, A.T., Haftom Yemane, H. (2016). Cow Milk Handling Practices and Factors Contributing to Quality Deterioration in Ethiopia. *Food Science and Quality Management*, 16: 48

Manga, B. S. Oyeleke B.S. (2008). *Essential of laboratory practical in Microbiology*, pp.20-32.

Matofari, J. W. Shalo P. L. Younan M. Nanua J. N. Adongo A. Qabale G. and Misiko B. N. (2013). Analysis of microbial quality and safety of camel (Camelus dromedarius) milk chain and implications in Kenya. *Journal of Agricultural Extension and Rural Development* 5(3): 50 – 54.

Mpatswenumugabo, J.P.M., Bebora, L.C., Gitao, G.C., Mobegi, V.A. and Shumbusho, B.I. (2019). Assessment of bacterial contamination and milk handling practices along the raw milk market chain in the north western Rwanda. *African Journal of Microbiology research*, 13(229): 640-648.

Murphy, S. C. and Boor K. J. (2000). Trouble shooting sources and causes of high bacteria ounts in raw milk. *Dairy Food and Environmental Sanitation*, 20(8): 606-611.

Newell, D.G. Koopmans M. Verhoef L. Duizer E. Aidara-Kan A. Sprong H. (2010). Food-borne diseases - the challenges of 20years ago still persist while new ones continue to emerge. *Int J Food Microbiol*. 139 (1): 3-15

Ngasala, J.B. Nonga H. E. Mtambo M.M.A. (2015). Assessment of raw milk quality and stakeholders' awareness on milk-borne health risks in Arusha City and Meru District, *Tropical Animal Health and Production*, Tanzania. 47(5): 927-932.

NPCR, (2017). National Population Commission Retrieved, 2006 census.

Odeyemi, O.A. Bamidele F.A. (2016). Harnessing the potentials of predictive microbiology in microbial food safety and quality research in Nigeria. *Future Science OA* 2(1): FSO. 91-93.

Oliver, S. P. Boor K. J. Murphy S. C. Murinda S. E. (2009). Food safety hazards associated with consumption of raw milk. *Foodborne Pathogens and Disease*, 6(7):793-806.

Pal, M. (2014). Spoilage of dairy products due to fungi. Beverage and Food World, (41):37-38, 40.

Pal, M. Mulu S. Tekle M. Pintoo S. V. Prajapati J. P. (2016). Bacterial contamination of dairy products. *Beverage and Food World*. (43):40-43.

Pires, S. M. Evers E.G. Pelt W. V. Ayers T. Scallan E. Angulo F. J. Havelaar A. Hald T. (2009). Attributing the Human Disease Burden of Foodborne Infections to Specific Sources. *Foodborne pathogens and disease*, 6(4):417-42.

Prajapat, J. B. (1995). *Fundamentals of dairy microbiology*. Aka Prakashal Nadiad, Gurajat, India. 445.

Ryan, K. J. and Ray C. G. (Eds.) (2004). *Sherris Medical Microbiology* McGraw Hill, UK. 733.

Sarkar, S. (2016). Microbiological Safety Concerns of Raw Milk. *Safety*: 24-25.

Tschirley, D. Reardon T. Dolislager M. and Snyder J. (2014). The rise of a middle class in East and Southern Africa: implications for food system transformation, Working Paper 119pp. World Institute for Development Economics Research (WIDER), Helsinki, Finland, http://www.mafs-africa.org/publications

Umofira, I. D. igwe J. C. Adeshina D. O. Ehinmidu J.O. Ojogo B.O. kachallah M. Enose O. D. Oladipo H.O. Adeboye S. Sidi M.T. Salihu M. S. and Aliyu A. (2014).bactriologicl examination of packaged milk market in Zaria, Nigeria. *International Journal of Current Research*, 6(8): 7836-7841

Velázquez-Ordoñez, V. B. Valladares-Carranza E. Tenorio-Borroto M. Talavera-Rojas J. A. Varela-Guerrero V. Acosta-Dibarrat and Puigvert F. (2019). *Microbial Contamination in Milk Quality and Health Risk of the Consumers of Raw Milk and Dairy Products*.