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Bacteriological and Physicochemical Study of Retailed Cow Milk collected from Different Locations in Birnin Kebbi

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Abstract

Milk is an excellent source of both major and minor components needed to meet the nutritional requirements of the human body. The current study was conducted to evaluate the bacteriological and physicochemical quality of cow milk collected from various locations in Birnin Kebbi. A total of twenty-four (24) milk samples (six from each location) were purchased. All samples were subjected to bacteriological analysis using total plate count, and physicochemical composition analysis, which included P^H, moisture content, fat content, protein content, and mineral determination (calcium, sodium, and potassium). The mean range for Total Plate Count is $1.83x10^6$-$3.42x10^6$ CFU/ML. Furthermore, bacteria isolated and identified from milk samples include Streptococcus spp, Shigella spp, Escherichia coli, Bacillus spp, Staphylococcus aureus, and Proteus spp. The physicochemical analysis results indicated that the mean range is P^H (4.87±0.04-5.52±0.05) Moisture content (82.22±0.60-87.50±2.16), Fat content (0.56±0.02-1.84±0.01), Protein content (11.27±4.4-12.55±4.99), Calcium (173.83±4.43-475.67±22.24), Sodium (11.83±4.26- 111±12.44) and Potassium (131±9.12-596±6.16) respectively. The study's findings highlight the poor bacteriological quality of milk, as evidenced by a higher Total Plate Count. Moreover, the presence of pathogenic microbes in milk, such as Bacillus spp, Shigella spp, and Escherichia coli, is likely to pose a serious public health risk. As a result, it is recommended that proper hygiene practices be implemented, as well as the incorporation of effective monitoring throughout the production to delivery chain.

Keywords **:** *Cow Milk, Bacteriological quality, Physicochemical Study, Total Plate Count. Birnin Kebbi*

1. INTRODUCTION

One of the most significant food products of animal origin is milk and milk products. Milk is universally recognized as a complete food that contains all of the nutrients that humans require. Milk is an essential component of both individual and family diets [1]. Milk is a substrate, whether it is processed, semi-processed, or raw, that is meant for human consumption (FAO/WHO). Humans have a long history of consuming animal milk, and cow's milk is the most common milk consumed in both developing and developed nations [2]. Milk has a significant nutritional value when consumed in its natural state. It contains more nutrients than any other single meal, including high-quality proteins, lipids, carbs, vitamins, and minerals.[3]. Cow's milk is produced in greater quantities than milk produced by other species around the world [4]. The primary factor determining the quality of its products is the quality of milk. A variety of dairy products, such as butter, cheese, cream, and others, are produced from cow's milk [5]. The majority of microbial contamination of milk and milk products occurs during milking, storage, transportation, and processing, and milk taken directly from a healthy udder is considered to be sterile (Vairamuthu et al., 2010). The safety and wholesomeness of milk intended for human consumption are influenced by a number of intricate and interconnected factors (Fox et al., 2017). Chemical composition, physical properties, microbiological and cytological quality, sensory properties, technological suitability, and nutritional value are all factors to consider (Walstra et al., 2006). Extrinsic and intrinsic compositional and structural factors, as well as temperature and post-milking treatments, influence its physical and chemical properties.

In Nigeria, like in other West African nations, the informal dairy sector dominates milk marketing, accounting for 95% of all milk sold. Nigeria produces 95% of its milk from pastoralists, while only 5% comes from industrial farms. Families of pastoralists consume and/or trade local pastoralist milk and dairy products through unofficial value chains. Rarely is pastoralist milk pasteurized before being sold or consumed [6]. Several regional foods can be made from milk, including nono (sour milk), Kindirmo (sour yogurt), Manshanu (local butter), cuku (Fulani cheese), and Wara (Yoruba cheese). Milk from commercial dairy farms is traded in urban and peri-urban marketplaces via formal value chains. Because they benefit smallholder farmers, small market vendors, and consumers in terms of higher farm gate prices, the creation of jobs, and competitive consumer prices, informal milk market routes are necessary (Consulting, 2019; NASS, 2011).

Both macronutrients and micronutrients are abundant in milk. On the other hand, if handled improperly, is highly perishable and can rapidly lose its quality and safety. Consequently, consumers face a serious health risk as a result of bacterial contamination of milk and dairy products [9]. Salmonella spp., Escherichia coli O157:H7, toxigenic Staphylococcus aureus, and Listeria monocytogenes, among other pathogenic microbes, can cause serious human infection in milk [10]–[12]. Additionally, zoonotic pathogens like Coxiella burnetii, Brucella spp., and Mycobacterium bovis can be spread by raw milk [13]. However, there is little information available on the quality of cow's milk in Birnin Kebbi. The purpose of this study was to assess the physicochemical and bacteriological quality of cow milk retailed in Birnin Kebbi, Kebbi State, Nigeria..

2. RESEARCH METHODS

2.1. Study Area

Birnin Kebbi is the capital state in North Western Nigeria. It falls within Latitude 12.4539ºN and Longitude 4.1975ºE of the equator. It is the administrative headquarters of Kebbi state and is located on the Sokoto River. It is connected by road to Argungu, Jega, and Bunza. Residents of the town are predominantly Hausas and Fulanis. Birnin kebbi is a tropical region with an average temperature of 32ºc. It is characterized by seasonal rainfall which usually commences in April and lasts until October, though with heavy fall in July and August.

2.2. Samples Collection

Milk samples were collected from Bulasa community Live Stock Investigation and Breeding Centre (BC), Yan Ya'ra market (YY), Tsohuwar kasuwa (TK), and Makera market (MK) Locations of Birnin Kebbi. A total of twenty-four (24) raw milk samples (six from each location) were purchased. Milk samples (30 mL in duplicate) were collected aseptically from each milk vendor and placed in sterile bottles for laboratory analysis. The samples were kept cool in a cool box on melting ice and transported to the laboratory within 5 hours of collection. The microbiology laboratory at Kebbi State University of Science and Technology Aliero (KSUSTA) was the place analysis was conducted. Samples were collected at two-week intervals for each sample site.

2.3. Bacteriological Analysis

2.3.1. Total Plate Count

In a separate test tube, one milliliter of each milk sample was transferred into nine (9 mL) of sterile distilled water. Each water sample was diluted using logarithms ranging from 10^{-1} to 10^{-3}. 1 mL of the desired aliquot is transferred to sterile Petri dishes, and the standard plate count was determined using the pour plate method [14].

2.3.2. Isolation and Identification of Bacteria

Based on gram reaction, colonial morphology, and biochemical characteristics, the isolates were identified. Catalase, Coagulase, Citrate Utilization, Indole, MR (Methyl Red), VP sugar fermentation test (Glucose, Sucrose, Lactose), Gas production test, and Urease are among the biochemical tests performed [14], [15].

2.4. Physicochemical Analysis of Milk Samples

All samples were subjected to physicochemical composition analysis, which included P^H, moisture content, fat content, protein content, and mineral determination (calcium, sodium, and potassium) using AOAC (2005) methods. A digital pH meter (Model 885, Max electronics, India) calibrated with pH 4 and 7 buffers were used to measure the pH. Moisture content was calculated by subtracting the known weight of the milk sample from the calculated weight of the total solid after evaporating the liquid component of the milk sample on a hot plate. The Gerber method was used to determine the fat content. The protein content was determined using the Kjeldahl method [16]. For mineral analysis, an atomic absorption spectrophotometer (A. Analyst 700, Perkin Elmer, USA) with a standard burner, air-acetylene flame, and hollow cathode lamps as a radiation source was used [17]..

3. RESULTS AND DISCUSSION

The study aimed to assess the bacteriological and physicochemical properties of various cow milk samples. The samples were then tested for Total Plate Counts (TPC), P^H, moisture content, fat content, protein content, and mineral determination (calcium, sodium, and potassium).

3.1. Total Plate Count

The Mean total viable count of milk samples from a different locations is displayed in Table 1. The mean range is $1.83x10^6$-$3.42x10^6$ CFU/ML. A lower total plate count result was recorded by Hasan et al., (2015) and Monika & Poonam, (2013) whereas, Woldemariam & Asres, (2017) reported SPC value higher than the current study. A higher standard plate count indicates an unsanitary condition. Poor storage temperature, long storage period after milking, health and hygiene of the cow, the environment where milking is done, and procedures used in cleaning and sanitizing the milking and storage equipment can all have an impact on high standard plate count [21], [22].

Table 1. Mean Total Plate Count of milk samples from different locations

Sample Location	Total Plate Count

CB	$3.42x10^6$
YY	$2.41x10^6$
TK	$1.83x10^6$
MM	$2.05x10^6$

3.2. Bacteria Species Isolated from Cow Milk

Streptococcus spp, Shigella spp, *Escherichia coli*, Bacillus spp, *Staphylococcus aureus*, and Proteus spp are the bacteria isolated and identified from the milk samples. Detection of bacterial pathogens including *Escherichia coli* and *Staphylococcus aureus* in this study match with Hasan et al., (2015) and Mogotu et al., (2022). If milk cans and lids are left unclean or improperly cleaned, thermophilic bacteria such as Bacillus cereus multiply. The presence of fecal *E. coli* indicates that excreta contamination has occurred [24]. Microbial pathogens can enter raw milk from the environment (contaminated utensils, feces, water, handlers) or infected udders/tissues of the producing animals [25].

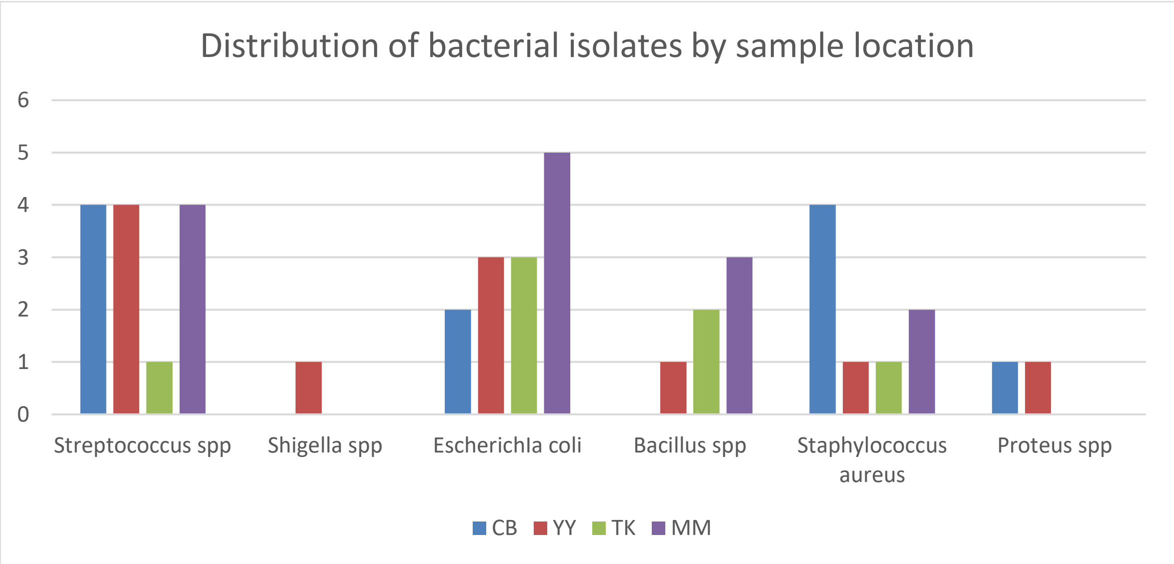

Figure 1. Distribution of Bacteria Species Isolated from Fresh Cow Milk by Location

3.3. Physicochemical Analysis of Milk Samples

The result of milk the P^H, moisture content, fat content, Protein content, and Mineral Determination (calcium, sodium, and potassium) are presented in Table 3. The mean range are PH (4.87±0.04-5.52±0.05) moisture content (82.22±0.60-87.50±2.16), fat content (0.56±0.02-1.84±0.01), Protein content (11.27±4.4-12.55±4.99),calcium (173.83±4.43-475.67±22.24), sodium(11.83±4.26- 111±12.44) and potassium (131±9.12-596±6.16) respectively. P^H value obtained in the present study is lower than the value found by Ekpa & Onuh, (2018) and Julia

Preka & Adem Bekteshi, (2016). Imran *et al*., (2008) reported milk pH in the range of 6.59±0.59 to 6.93±0.57. The results of moisture content revealed that milk has higher moisture content than the previous value (92.421+0.082) reported by Prasad *et al*., (2018). Gasmalla et al., (2013) recorded the value of the moisture content lower than the present investigation. The fat content reported by Abay et al., (2018) and Tan et al., (2020) was higher than that of the present study. Moreover, our study has shown that the protein content was slightly lower than the report of Julia Preka & Adem Bekteshi, (2016), Abay *et al*., (2018), and Legesse *et al*., (2017). This study revealed lower fat, protein, and water content in the selected milk samples. Milk obtained from the local market with reduced-fat contents can be attributed to water adulteration. The calcium, sodium, and potassium results of this study are less than the ranges of the previous studies as detected by Barłowska et al., (2011) and Imran et al., (2008). The high levels of heavy metals found in this study could be attributed to the high contamination of animal feed and water by such pollutants, and they could be excreted in milk at varying levels.

Table 2: Mean physicochemical values (mean ± SD) of milk samples from different locations

Sample Location	P^H	Moisture content (%)	Fat content (%)	Protein content (%)	NA(mg/L)	CA(mg/L)	K(mg/L)
CB	5.50±0.20	86.23±2.02	1.84±0.01	12.20±4.66	105.8±6.85	173.83±4.43	436.5±14.28
YY	5.52±0.05	84.56±1.23	0.85±0.008	12.55±4.99	11.83±4.26	475.67±22.24	596±6.16
TK	4.94±0.04	87.50±2.16	1.06±0.063	11.27±4.4	82.67±8.96	355±38.66	131±9.12
MM	4.87±0.04	82.22±0.60	0.56±0.02	12.26±5.0	111±12.44	326.5±9.63	484.3±17.91

NA=SODIUM, CA=CALCIUM, K=POTASSIUM

4. CONCLUSION

Milk is a rich source of major and minor components that are required to meet the nutritional needs of the human body. However, the study's findings highlight the poor bacteriological quality of milk, as evidenced by a higher total plate count. This is most likely due to poor handling, the use of unsterile milk transport equipment, and the study area's high ambient temperature. Furthermore, the presence of pathogenic microbes such as Bacillus, Shigella, and Escherichia coli in milk is likely to pose a serious public health risk. These findings emphasize the importance of implementing improved hygiene practices and incorporating effective monitoring throughout the production to the delivery chain.

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