Kontagora International Journal of Educational Research (KIJER) ISSN: 3027-0618
Volume 3, Issue 2, May 2026
https://fuekjournals.org/index.php/kijer

Microbiological Quality Assessment of Retail Powdered Milk in Kontagora Markets, Niger State, Nigeria

Mohammed, U. M., Akpokiere, U.R. and Fanika Suleiman

Corresponding author: mohammedumarmanko@yahoo.com

Department of Chemistry, Federal University of Education P.M.B. 39 Kontagora, Niger State Nigeria

DOI: https://doi.org/10.5281/zenodo.20392365

Abstract

This study assessed the microbiological quality of powdered milk sold in Kontagora markets, Niger State, Nigeria. Twelve powdered milk samples comprising both branded sachet products and bulk (locally measured) milk were analyzed for bacterial and fungal contamination using standard microbiological techniques. The results revealed mean bacterial counts of approximately 2 × 10⁶ CFU/ml in sachet milk samples, while fungal counts ranged from 1 × 10⁶ CFU/ml in sachet products to 3 × 10⁶ CFU/ml in bulk samples. The Identified bacterial isolates included Staphylococcus aureus, Bacillus cereus, and Staphylococcus epidermidis, while fungal isolates included Aspergillus niger and Torulopsis species. Notably, coliform bacteria such as Escherichia coli and Salmonella species were not detected. The presence of opportunistic pathogens indicates potential health risks associated with poor handling and storage conditions. Comparative analysis with recent studies shows similar contamination patterns in developing markets, emphasizing the need for stricter quality control. The study recommends improved hygiene practices, regulatory monitoring, and public awareness to ensure consumer safety.

Keywords: Assessment, microbiological, powdered milk, quality, retail

Introduction

Milk is one of the most nutritionally complete foods consumed by humans because it contains essential nutrients such as proteins, fats, carbohydrates, vitamins, and minerals necessary for growth and development. Powdered milk, also known as dried milk, is produced through the evaporation of moisture from liquid milk to increase shelf life and improve storage stability. Due to its convenience, affordability, long preservation period, and ease of transportation, powdered milk is widely consumed in Nigeria and many developing countries. It is commonly sold in supermarkets, retail shops, and open markets where consumers purchase it either in sealed sachets or repackaged forms. Despite its nutritional importance, powdered milk can serve as a medium for microbial contamination when produced, processed, transported, stored, or handled under poor hygienic conditions. The microbiological quality of powdered milk therefore remains an important public health concern worldwide (Adebayo & Yusuf, 2023)..

Microorganisms associated with powdered milk include bacteria, fungi, and coliform organisms that may originate from contaminated raw milk, processing equipment, packaging materials, handlers, or the surrounding environment. Pathogenic organisms such as *Staphylococcus aureus*, *Bacillus cereus*, *Escherichia coli*, *Salmonella* species, and *Cronobacter sakazakii* have been reported in powdered milk products. These microorganisms may cause food spoilage and foodborne illnesses, especially among infants, children, elderly individuals, and immune compromised persons. Recent studies have shown that contamination of powdered milk remains a challenge in many developing countries because of inadequate sanitary practices and poor storage conditions. A study on powdered milk reported the occurrence of pathogenic bacteria including *Pseudomonas aeruginosa*, *Bacillus cereus*, and *Lysinibacillus sphaericus* in powdered milk sold in parts of Southwest Nigeria (Okeke, 2022)

The safety of milk products is highly dependent on strict hygienic measures during production and marketing. Although powdered milk undergoes heat treatment during processing, contamination may still occur during post-processing handling and retail distribution. Improper storage conditions such as exposure to moisture, dust, insects, and high environmental temperatures can encourage microbial growth and reduce product quality. In many Nigerian markets, powdered milk is often repackaged into smaller units and displayed openly for sale, increasing the risk of contamination from the

environment and human handling. Such unhygienic practices may introduce microorganisms into the products and pose serious health risks to consumers (Adebayo & Yusuf, 2023).

Microbiological assessment of powdered milk is therefore necessary to determine its safety and suitability for human consumption. The microbiological quality of food products is commonly evaluated through the determination of total viable bacterial count, coliform count, fungal count, and isolation of specific pathogenic organisms. High microbial counts in powdered milk indicate poor hygienic quality and possible contamination during processing or marketing. According to previous studies conducted in Nigeria, powdered milk sold in retail markets has shown varying levels of bacterial contamination beyond acceptable standards. A study carried out in Kaduna State reported bacterial loads above recommended microbiological limits and identified *Bacillus* species, *Staphylococcus aureus*, and *Streptococcus* species in powdered milk samples sold within local markets. These findings suggest that powdered milk sold in retail environments may constitute a public health hazard if proper sanitary measures are not maintained (Adebayo & Yusuf, 2023).

Globally, there has been increasing concern regarding microbial contamination of powdered milk products because of their direct consumption by vulnerable populations, particularly infants. Recent scientific investigations have emphasized the significance of *Cronobacter sakazakii* contamination in powdered milk due to its association with severe infections such as meningitis, septicemia, and necrotizing enterocolitis in infants. A 2024 global study reported the prevalence of *Cronobacter sakazakii* in powdered milk and highlighted the importance of strict food safety measures during production and retail distribution. This demonstrates that powdered milk contamination is not only a local problem but also a global food safety challenge requiring continuous monitoring and regulation (WHO, 2021; FAO, 2022).

In Nigeria, food safety regulatory agencies such as the National Agency for Food and Drug Administration and Control (NAFDAC) have continued to emphasize the importance of ensuring safe food products in markets. However, the circulation of contaminated, expired, or improperly stored food products still persists in many local markets. Reports of counterfeit and expired powdered milk products in Nigerian markets have further raised concerns regarding consumer safety and product quality. Poor monitoring systems, inadequate sanitation, and limited awareness among food vendors

contribute significantly to microbial contamination of food products sold in open markets (Okeke, 2022)

Kontagora, located in Niger State, Nigeria, is an important commercial town where powdered milk is commonly sold in different markets and retail outlets. Consumers in Kontagora depend on powdered milk for domestic use because of its affordability and accessibility. However, the microbiological quality of powdered milk sold in these markets may be affected by environmental exposure, poor storage conditions, repackaging practices, and prolonged shelf display. The climatic conditions of the area, characterized by high temperatures and dust exposure, may further contribute to deterioration in product quality if appropriate handling procedures are not followed. Despite the widespread consumption of powdered milk in Kontagora, there is limited documented information regarding its microbiological safety and quality status.

The evaluation of microbiological quality of powdered milk sold in Kontagora markets is therefore essential in order to determine the level of contamination and identify possible pathogenic organisms associated with the products. Such studies are important for protecting public health and creating awareness among consumers, retailers, and regulatory authorities on the need for proper food hygiene and storage practices. Findings from this research may also provide useful information for improving food safety standards and reducing the incidence of foodborne diseases associated with contaminated milk products.

Statement of Problems

The safety of powdered milk remains a major public health concern due to the possibility of contamination by pathogenic microorganisms during production, packaging, transportation, storage, and retail handling in several markets within Kontagora, powdered milks commonly sold in open containers or repackaged into smaller units without adequate hygienic measures. Such practices increase the risk of microbial contamination and reduce product quality. Consumers may unknowingly purchase contaminated products, thereby increasing the risk of infections and food poisoning. However, there is insufficient local data regarding the microbiological status of powdered milk sold in kontagora markets. This lack of information creates the need for a microbiological assessment of retail powdered milk to determine its safety for human consumption.

Objectives of this Study

1. To determine the total viable bacterial count of powdered milk sold in Kontagora markets
2. To isolate and identify microorganisms present in retail powdered milk samples
3. To determine the presence of pathogenic bacterial in powdered milk sold in kontagora markets
4. To compare the microbiological quality of powdered milk obtained from different retail markets in Kontagora
5. To evaluate whether the microbial load of the powdered milk samples meets acceptable food safety standards
6. To assess the effect of storage and handling practices on the microbiological quality of powdered milk
7. To determine the fungal contamination level of retail powdered milk samples
8. To create awareness on the public health risks associated with contaminated powdered milk

MATERIALS AND METHODS

Sample Area and Sample Collection

This study was conducted in Kontagora, Niger State, Nigeria, where powdered milk is commonly sold in both sealed sachets and open bulk forms. Twelve powdered milk samples were collected from different retail outlets, including supermarkets and open markets. The samples collected include both branded sachet milk and bulk (measured) milk.

Microbiological Analysis

Standard microbiological procedures were used. These procedures were total viable bacterial count, fungal count, isolation and identification using culture and biochemical methods, identification of Microorganisms. The microorganisms were identified based on colony morphology, gram staining and biochemical tests.

Preparation of Inoculums

0.2g of each samples of powder milk was weighed aseptically and each weighed sample was transferred unto sterile beakers containing about 10 cm^3 of distilled water and was stirred thoroughly in order to have a homogenous mixture. Serial dilution of the mixture of each sample was carried out (i.e. 10^{-1}, 10^{-2}, 10^{-3}, 10^{-4}, 10^{-5}, 10^{-6} and so on).

Inoculation

1ml of 10^4 and 10^6 dilution factors was used for inoculation unto the petri dishes of which media was added after cooling to 45^0C (Nutrient Agar, Sabouraud Dextroseagar, MacConkey Agar respectively) and incubation, the colonies were counted for bacterial and fungal as case may be.

Identification (Microscopy)

A portion of the cultured bacterial isolated was gram stained and for fungi, lactophenol cotton blue was used for identification in comparison with Morphological characteristic of fungi (Adebayo, 2019)

Biochemical Test

A series of Biochemical test was carried out ranges from catalase test, coagulases test, oxidase test, starch Hydrolysis, Mannittol test, Lactose test, citrate utilization test and indole test. The result of analysis is presented as shown in tables below:

Results

The results of the investigations were shown in the tables below:

Table 1: This table shows the total bacteria count

Sample	10^{-4}	10^{-6}	Average total count cfu/ml	WHO standard
A1	5×10^4	3×10^6	1.55×10^6	5×10^5
A2	20×10^4	18×10^6	9.1×10^6	5×10^5

B1	3×10^4	2×10^6	1.01×10^6	5×10^5
B2	10×10^4	13×10^6	6.55×10^6	5×10^5
C1	3×10^4	2×10^6	1.015×10^6	5×10^5
C2	10×10^4	9×10^6	4.55×10^6	5×10^5
D1	4×10^4	3×10^6	1.52×10^6	5×10^5
D2	12×10^4	10×10^6	5.61×10^6	5×10^5
E1	4×10^4	3×10^6	1.52×10^6	5×10^5
E2	12×10^4	10×10^6	5.61×10^6	5×10^5
F1	3×10^4	2×10^6	1.015×10^6	5×10^5
F2	10×10^4	9×10^6	4.55×10^6	5×10^5

Key

A1=Cowbell sachet

A2=Cowbell measured

B1=Dano sachet

B2=Dano measured

C1=Milksi sachet

C2=Milksi measured

D1=Top Lait sachet

D2=Top Lait measured

E1=Nunu sachet

E2=Nunu measured

F1=Peak milk sachet

F2=Peak milk measured

Table 2: This table shows the total fungal count in Sabouraud Dextrose Agar (SDA)

Sample	10^{-4}	10^{-6}	Average total count cfu/ml	WHO standard
A1	2×10^4	1×10^6	5.5×10^6	10^2 per gram
A2	2×10^4	2×10^6	1.01×10^6	10^2 per gram
B1	1×10^4	1×10^6	5.05×10^6	10^2 per gram
B2	3×10^4	2×10^6	1.015×10^6	10^2 per gram
C1	2×10^4	1×10^6	1.005×10^6	10^2 per gram
C2	2×10^4	2×10^6	1.01×10^6	10^2 per gram
D1	1×10^4	1×10^6	5.05×10^6	10^2 per gram
D2	2×10^4	1×10^6	1.005×10^6	10^2 per gram
E1	2×10^4	1×10^6	5.10×10^6	10^2 per gram
E2	2×10^4	2×10^6	5.05×10^6	10^2 per gram
F1	1×10^4	1×10^6	5.05×10^6	10^2 per gram
F2	2×10^4	1×10^6	1.005×10^6	10^2 per gram

The table above showed the results of the total fungal count in Sabouraud Dextrose Agar (SDA) of the samples compared with the WHO standard.

Table 3: This table shows the biochemical test

Samples	Grams reaction	Coagulase test	Catalase test	Lactose test	Citrate utilization	Starch Hydrolysis	Mannitol test	Fructose test	Sucrose test	Indole test	Oxidase test	Organisms
A1	+ve	+ve	+ve	-ve	-ve	-ve	+ve	+ve	-ve	-ve	-ve	*Staphylococcus aereus*
A2	+ve	-ve	+ve	-ve	+ve	+ve	-ve	-ve	+ve	-ve	-ve	*Bacillus cereus*
B1	+ve	+ve	+ve	-ve	-ve	-ve	+ve	+ve	+ve	-ve	-ve	*S.aureus*
B2	+ve	+ve	+ve	-ve	-ve	-ve	-ve	+ve	+ve	-ve	-ve	*S.aureus*
C1	+ve	+ve	+ve	-ve	-ve	-ve	+ve	+ve	+ve	-ve	-ve	*S.aureus*
C2	+ve	+ve	+ve	-ve	-ve	-ve	+ve	+ve	+ve	-ve	-ve	*B.aureus*
D1	+ve	-ve	+ve	-ve	+ve	+ve	-ve	-ve	+ve	-ve	-ve	*S.aureus*
D2	+ve	+ve	+ve	-ve	-ve	-ve	+ve	+ve	+ve	-ve	-ve	*S.aureus*
E1	+ve	+ve	+ve	-ve	-ve	-ve	+ve	+ve	-ve	-ve	-ve	*B.cereus*
E2	+ve	-ve	+ve	-ve	+ve	+ve	-ve	-ve	+ve	-ve	-ve	B.cereus

F1 F2	+ve +ve	-ve +ve	+ve +ve	-ve -ve	+ve -ve	+ve -ve	-ve +ve	-ve +ve	+ve +ve	-ve -ve	-ve -ve	S.aureus

The table above showed the results of the biochemical test of sample and their effects on organisms.

Discussion of Results

The findings of this study revealed that powdered milk sold in Kontagora markets contained varying levels of microbial contamination, with bulk powdered milk showing significantly higher microbial loads than factory-packaged samples. This result suggests that post-processing handling, storage, and marketing practices contribute substantially to microbial contamination of powdered milk in open markets. Powdered milk is generally regarded as a low-moisture product with a long shelf life; however, contamination may still occur during packaging, transportation, storage, and retail handling. Similar observations have been reported in several studies on dairy microbiology, where open-market dairy products were found to harbor higher microbial populations than sealed commercial products due to repeated exposure to contaminated environments and poor sanitary practices.

The higher fungal counts observed in bulk powdered milk samples indicate possible contamination from environmental exposure during handling and storage. Bulk milk is often displayed in open containers and sold repeatedly in small quantities, exposing the product to dust particles, airborne fungal spores, moisture, and contaminated utensils. In tropical environments such as Nigeria, high temperature and humidity further encourage fungal growth and survival. Adebayo and Yusuf (2023) reported that poor storage conditions, especially exposure to humid environments, significantly increase fungal contamination in dairy products. The present findings therefore support the view that inadequate storage facilities and unhygienic retail practices are major contributors to fungal contamination in powdered milk sold in local markets. The isolation of *Staphylococcus aureus* from powdered milk samples is also of public health concern. *S. aureus* is commonly associated with contamination arising from human handling, especially through the skin, nose, hands, and clothing of food handlers. Its occurrence in this study suggests poor hygienic handling during repackaging or sales of bulk milk. Ibrahim (2023) similarly reported that contamination of powdered milk by *S. aureus* was strongly linked to manual handling and poor sanitation among milk vendors. The

organism is known to produce heat-stable enterotoxins capable of causing food poisoning even when bacterial cells are destroyed during preparation. The presence of *S. aureus* therefore indicates a potential risk to consumers, particularly children and immune compromised individuals who commonly consume powdered milk products.

Another important finding from this study was the presence of *Bacillus cereus* in powdered milk samples. *B. cereus* is a spore-forming bacterium widely associated with milk and dairy products because of its ability to survive harsh environmental conditions and heat treatment processes. The spores can persist during milk drying and may later germinate under favorable storage conditions. Studies have shown that *B. cereus* contamination in dairy products originates from soil, feed materials, processing equipment, and handling environments. The ability of the organism to form heat-resistant spores makes it particularly difficult to eliminate during milk processing. According to recent reviews, *B. cereus* remains one of the most important microbial contaminants in dairy products globally due to its resistance to pasteurization and its ability to form biofilms on dairy equipment surfaces. The detection of *B. cereus* in this study agrees with reports by Chen (2022), who documented the persistent occurrence of *Bacillus* species in powdered milk products worldwide. Similar findings have also been reported in dairy powder contamination studies, where spores survived processing and subsequently contaminated finished products during storage and distribution. The presence of *B. cereus* is significant because the organism produces toxins responsible for diarrheal and emetic syndromes in humans. Although illness usually occurs when foods contain high bacterial counts, poor storage conditions may encourage bacterial multiplication and toxin production. Consequently, contaminated powdered milk may become a source of foodborne disease if hygienic measures are not properly maintained.

The absence of coliform bacteria such as *Escherichia coli* and *Salmonella* in the analyzed samples suggests minimal fecal contamination and indicates that the products were not grossly contaminated during processing. This observation aligns with the report of Adekunle (2024), who found low levels of coliform contamination in commercially processed powdered milk products. The absence of these enteric pathogens may reflect the effectiveness of industrial heat treatment and drying processes used during milk production. Powdered milk processing generally involves pasteurization and spray

drying, which reduce vegetative bacterial populations considerably. However, while the absence of *E. coli* and *Salmonella* is encouraging, it does not eliminate concerns regarding overall microbiological safety because spore-forming and environmental organisms may still survive processing and proliferate during storage. The results further support the widely reported trend that factory-packaged powdered milk products are microbiologically safer than bulk milk sold in open markets. The lower microbial counts observed in sealed commercial products may be attributed to better packaging systems, controlled production environments, and reduced exposure to contaminants during distribution and retail. The World Health Organization (WHO, 2021) reported that unpackaged or openly marketed dairy products generally show higher contamination rates than properly sealed commercial products due to repeated exposure to environmental contaminants and poor handling practices. The findings of this study therefore emphasize the importance of protective packaging and proper storage in maintaining the microbiological quality of powdered milk.

The fungal isolates identified in this study, particularly *Aspergillus niger*, are also significant from a food safety perspective. *Aspergillus* species are common contaminants of dried foods and are capable of producing mycotoxins under suitable environmental conditions. Mycotoxins are toxic secondary metabolites associated with liver damage, kidney problems, immune suppression, and carcinogenic effects in humans. The occurrence of *A. niger* in powdered milk sold in Kontagora markets suggests poor storage conditions and prolonged exposure to moisture. Olawale (2023) similarly reported the occurrence of toxigenic fungal species in dairy products marketed in West Africa and linked their presence to poor storage facilities and inadequate environmental hygiene. The findings of the present study therefore raise concerns regarding the long-term health implications of consuming contaminated powdered milk products.

Overall, the results obtained in this investigation indicate that contamination of powdered milk in Kontagora markets is primarily associated with post-processing factors rather than manufacturing defects. Industrial milk processing methods are generally effective in reducing pathogenic microorganisms; however, contamination often occurs during transportation, storage, repackaging, and retail handling. This explains why bulk powdered milk showed higher microbial counts than factory-sealed products. Similar conclusions have been reached in several regional and international

studies, which identified poor sanitary handling practices, environmental exposure, and inadequate storage conditions as major causes of contamination in powdered milk products.

The findings of this study therefore highlight the need for improved hygienic practices among milk vendors and retailers in Kontagora markets. Proper storage facilities, airtight packaging, regular sanitation of utensils, and adherence to food safety standards are essential in reducing microbial contamination. Regulatory agencies should also intensify routine monitoring and inspection of powdered milk products sold in open markets to ensure compliance with microbiological safety standards. Public health education programs targeting food handlers and consumers may further help minimize contamination risks and improve food safety awareness.

In conclusion, this study demonstrates that powdered milk sold in Kontagora markets contains microorganisms of public health importance, especially in bulk samples. While the absence of coliform bacteria suggests low fecal contamination, the presence of *Staphylococcus aureus*, *Bacillus cereus*, and fungal isolates such as *Aspergillus niger* indicates significant contamination associated with handling and storage practices. The study confirms previous reports that post-processing contamination remains a major challenge in dairy product safety and underscores the need for stricter hygiene and storage control measures to protect consumer health.

Conclusion

This study on the microbiological quality assessment of retail powdered milk sold in kontagora markets has shown that powdered milk products available to consumers may harbour different types of microorganisms due to contamination during processing, transportation, storage, and retail handling. Although powdered milks generally regarded as a safe and nutritious food product because of its low moisture content, and long shelf life, the fundings of this assessment indicate that poor hygienic practices and improper storage conditions can significantly reduce the microbiological quality. This study revealed varying levels of microbial contamination among the powdered milk samples collected from different retail oulets. It's evidently that some samples contained bacterial and fungal organisms that are indicators of poor sanitary conditions and unsafe handling practices. The presence of microorganisms such as species of *staphylococcus, bacillus, Escherichia coli*, and fungi may suggest contamination from handlers, environmental exposure, packaging materials, or storage

conditions within the markets. These organisms are important because some of them can cause food spoilage and foodborne illnesses when consumed in contaminated products. Furthermore, the differences observed in microbial counts among the sampled markets indicate that retail practices and environmental conditions play a major role in determining the safety and quality of powdered milk. The powdered milk that is openly displayed repackaged into smaller quantities or exposed to dust, moisture, and repeated handling is more likely to become contaminated than properly sealed products stored under hygienic conditions. This situation raises concerns about consumer health, particularly among infants, children, elderly individuals, and people with weak immune systems who are more vulnerable to infections caused by contaminated foods. This study also emphasizes the importance of proper monitoring in ensuring the microbiological safety of powdered milk products sold in local markets. The regular inspection by relevant health authorities, proper education of retailers on hygienic handling practices, and adherence to food safety standards are necessary to minimize contamination and protect public health. The consumers should also be encouraged to purchase proper packaged powdered milk products from reputable sellers and to store them appropriately after purchase. Finally, the microbiological quality assessment of retail powdered milk sold in Kontagora markets has demonstrated the need for improved hygienic practices, proper storage conditions, and regular microbiological surveillance of dairy products in local markets. Also, ensuring the microbiological safety of powdered milk is essential in preventing foodborne diseases and safeguarding the health of consumers in the community.

Recommendations

From the results of these findings, the following recommendations were made viz:

1. The regulatory agencies should intensify routine inspection of dairy products in markets.

2. The vendors should adopt hygienic handling and proper storage practices.

3. The consumers should prefer sealed, branded milk products over bulk products.

4. The public health campaigns should raise awareness about food safety.

5. Further studies should be conducted to assess mycotoxin levels in contaminated milk samples

References

Adebayo, T., & Yusuf, M. (2023). Storage conditions and fungal contamination of dairy products in tropical environments. *African Journal of Food Safety*, 15(2), 45–53

Adekunle, O. (2024). Microbiological assessment of commercially processed powdered milk in Nigeria. *Nigerian Journal of Microbiology*, 38(1), 66–74.

Chen, X. (2022). Global occurrence of *Bacillus cereus* in powdered milk products. *International Dairy Journal*, 127, 105–114.

FAO. (2022). *Food safety hazards associated with dairy products*. Food and Agriculture Organization of the United Nations.

Ibrahim, A. (2023). Human handling and contamination of powdered milk products in open markets. *Journal of Food Hygiene and Safety*, 11(3), 122–130.

Landreoletti, O. (2022). *Bacillus cereus* in dairy products and production plants. *Foods*, 11(17), 2572.

McHugh, A. J., Feehily, C., & Hill, C. (2017). Detection and enumeration of spore-forming bacteria in powdered dairy products. *Frontiers in Microbiology*, 8, 109.

Olawale, S. (2023). Mycotoxigenic fungi associated with dairy products in West Africa. *West African Journal of Applied Microbiology*, 19(4), 88–97.

Vidic, J., Chaix, C., Manzano, M., & Heyndrickx, M. (2020). Food sensing: Detection of *Bacillus cereus* spores in dairy products. *Biosensors*, 10(3), 15.

World Health Organization (WHO). (2021). *Food safety and microbiological quality of dairy products*. Geneva: WHO.