A Case Study on the Microbial Safety of Imported Milk in a Facility in Lagos State: A Public Health Perspective

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ABSTRACT

The microbial safety of milk products is a crucial public health concern globally, particularly in settings where milk is widely consumed and prone to contamination. This case study assesses the microbial safety of imported milk products in a processing facility located in Lagos State, Nigeria, focusing on key bacterial pathogens including Salmonella species, Escherichia coli, and Shigella species. Milk powder, evaporated milk, and flavored drinking yoghurts were sampled, representing commonly consumed imported dairy products in the region. Using standard microbiological techniques aligned with international food safety protocols, each sample was tested for the presence of these pathogens. A total of eleven batches were analyzed, with all samples testing negative for Salmonella, E. coli, and Shigella. This absence of pathogenic bacteria highlights the effectiveness of sanitary measures in the handling, processing, and storage of these imported milk products at the facility, indicating compliance with food safety standards. The study contextualizes these findings within the broader public health perspective of Nigeria, where locally produced milk often exhibits higher microbial contamination risks due to challenges in hygiene, handling, and storage. Imported milk products, subject to more stringent quality controls and pasteurization standards, therefore offer a safer alternative. These results underscore the importance of continuous surveillance and rigorous quality assurance to maintain consumer safety and prevent foodborne illnesses linked to dairy consumption. This case study contributes to the literature by providing empirical data confirming the microbial safety of imported milk products in Lagos State and reinforces public health policies advocating for strict microbial monitoring of dairy imports. Further research could expand surveillance to include additional microbial contaminants and investigate supply chain controls to sustain and improve dairy product safety. This knowledge is valuable for stakeholders in public health, food safety regulation, and dairy importation sectors aiming to protect the Nigerian population's health.

Keywords: *Microbial safety, imported milk, Salmonella, Escherichia coli, Shigella, Lagos State, public health, dairy products*

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INTRODUCTION

Milk and dairy products are integral components of human nutrition globally, providing a rich source of essential nutrients such as proteins, fats, vitamins, and minerals (Akinyemi *et al.*, 2025). However, while they are vital for health, milk and milk-derived products also pose significant public health risks due to their susceptibility to microbial contamination at various stages of production, processing, and distribution (Oduori *et al.*, 2022).

The microbial safety of milk is influenced by diverse factors, including hygiene practices during milking, handling procedures, environmental conditions, and storage methods (Uzoaga *et al*., 2020). Contaminants of primary concern include pathogenic bacteria such as *Salmonella* spp., *Escherichia coli*, and *Shigella* spp., which are associated with severe foodborne illnesses worldwide.

In developing countries like Nigeria, the burden of microbial contamination in milk is alarmingly high due to inadequate hygienic practices, weak regulatory frameworks, and informal dairy supply chains. Locally produced milk often exhibits high bacterial loads, elevated levels of coliforms, and the presence of pathogenic microorganisms, primarily resulting from poor milking hygiene, unhygienic handling, and unsanitary environmental conditions (Uzoaga *et al*., 2020). This compels consumers to seek alternatives through imported dairy products, which are often subjected to stricter quality controls and processing standards such as pasteurization, to reduce microbial risks.

However, the recent surge in milk importation into Nigeria, especially in Lagos State an economic hub with high consumption rates raises questions regarding the microbiological safety of these products. The importation of milk powder, evaporated milk, and flavored yoghurts has surged to bridge the gap between local production shortfalls and demand (Uzoaga *et al*., 2020). Despite being processed under more controlled environments, concerns persist about the integrity of imported dairy, especially during storage, transportation, and distribution, where contamination can occur due to lapses in hygiene or breaches in cold chain logistics.

Globally, the microbiological quality of imported milk products has gained increasing attention, with studies indicating that contamination with pathogens such as *E. coli* including multidrug-resistant strains and *Salmonella* spp. is linked to adverse health outcomes such as diarrhea, dysentery, and even septicemia (WHO, 2023). The World Health Organization underscores the importance of stringent safety protocols in ensuring dairy safety, with a focus on microbial surveillance, effective pasteurization, and hygienic handling practices (WHO, 2023).

Research in Nigeria demonstrates that the microbial contamination of locally sold and imported milk varies significantly based on handling practices and regulatory enforcement. A recent study on fermented milk (nono), a locally processed product in Nigeria, found high bacterial counts with significant presence of *E. coli* and Staphylococcus aureus, often exceeding international safety standards like Codex Alimentarius and the European Union regulations (Uzoaga *et al*., 2020). These findings highlight the prominent health risks associated with unregulated or poorly regulated milk supply chains and emphasize the need for regular microbial monitoring of imported products.

In Lagos State, as one of Nigeria's fastest-growing urban centers and economic hubs, the demand for imported dairy products has increased markedly, driven by urbanization, changing consumption patterns, and insufficient local dairy production capacity. While imported milk products are generally produced under stringent international standards, lapses in storage or transportation can reintroduce contamination risks. Thus, evaluating the microbial safety of these imported dairy products remains crucial for public health protection. This study aims to assess the microbial quality of imported milk products in a Lagos State facility through microbiological testing for *Salmonella* spp., *E. coli*, and *Shigella* spp., which are major contributors to foodborne disease burdens. The findings will provide valuable insights into the safety status of imported dairy, informing regulatory bodies, health agencies, and stakeholders involved in food safety management. Moreover, this work underscores the importance of implementing continuous microbial monitoring, adhering to international safety standards, and strengthening Nigeria's regulatory framework to minimize the risk of foodborne illnesses associated with milk consumption.

MATERIALS AND METHODS

Study Area

The study was conducted in Lagos State, Nigeria, which is the commercial capital and one of the most populous states in the country. Lagos is a major hub for the importation and distribution of milk and dairy products due to its extensive consumer market (Figure 1). The sampled milk products were obtained from a certified dairy processing and distribution facility in Lagos that handles imported milk powder, evaporated milk, and flavored drinking yoghurts for retail.

Figure 1: Map of Lagos State as the Study Area (Source: Saulawa *et al*., 2024)

Sample Collection

A total of eleven batches of imported milk products were sampled aseptically.

These included five milk powder batches (Batch numbers: BF0161N24, BF0142N24, BF0144N24, BF0176N24, 23193992), one batch of evaporated milk (Batch number: 24723CBD), and five batches of flavored drinking yoghurts (Batch numbers: 25623CD608, 25623CD609, 25623CD610, 25623CD567, 25623CD568). The samples were collected in sterile containers, labeled accordingly, and transported in an unbroken cold chain at 4±2°C to the microbiology laboratory of the facility for immediate analysis, thereby preserving the microbial integrity of the samples (Uzoaga *et al*., 2020).

Microbiological Analysis

The microbial safety assessment focused on detecting three important bacterial pathogens: *Salmonella* species, *Escherichia coli* (*E. coli*), and *Shigella* species. These pathogens are commonly implicated in milk borne foodborne illnesses and constitute key indicators of fecal contamination and pathogenic risk.

Sample Preparation

Milk powders were reconstituted in sterile distilled water according to manufacturer instructions to simulate their liquid form. Evaporated milk and drinking yoghurt samples were tested without dilution, as they represent ready-to-consume products.

Pre-enrichment

Twenty-five grams or milliliters of each sample were placed in buffered peptone water and incubated at 37°C for 18–24 hours to resuscitate any stressed or injured bacterial cells and increase the sensitivity of pathogen detection (FAO/WHO, 2023).

Selective Enrichment

The pre-enriched samples were transferred to selective broths designed to favor the growth of target pathogens: Rappaport-Vassiliadis broth for *Salmonella* and Selenite cystine broth for both *Salmonella* and *Shigella*. These broths suppress competing microflora while enhancing pathogen recovery.

Selective Plating

Following incubation, aliquots from enrichment broths were streaked onto selective chromogenic agar media; Xylose Lysine Deoxycholate (XLD) agar for detection of *Salmonella* and *Shigella* species. Eosin Methylene Blue (EMB) agar for isolation of *Escherichia coli*. Plates were incubated aerobically at 37°C for 24 hours.

Identification and Confirmation

Suspected colonies were identified through characteristic colony morphology and color changes on the selective media; *Salmonella* colonies typically appear red with black centers on XLD agar. *Shigella* colonies appear red or pink without black centers on XLD. *E. coli* produces colonies with a metallic green sheen on EMB agar. Further confirmatory biochemical tests performed included Triple Sugar Iron (TSI) test, indole production, urease test, and citrate utilization tests, following standard microbiological protocols (Uzoaga *et al*., 2020).

Optionally, PCR assays targeting specific pathogen genes (invA for *Salmonella*, uidA for *E. coli*, and ipaH for *Shigella*) were employed to confirm isolates, enhancing the specificity and sensitivity of detection when necessary.

Quality Control

All microbiological media and reagents were prepared according to manufacturer instructions and sterilized by autoclaving. Positive control strains of *Salmonella* spp., *E. coli*, and *Shigella* spp., as well as negative controls, were run in parallel to ensure reliability and validity of the test results. Each test was performed in triplicate to ensure reproducibility and accuracy (Uzoaga *et al*., 2020).

Data Recording

Results for each batch were recorded as either positive or negative for the presence of the targeted bacterial pathogens. The absence of characteristic colonies on selective media and negative biochemical or molecular tests indicated a negative result for that pathogen.

RESULTS

The microbiological analysis of the eleven imported milk product batches from the Lagos State facility revealed no detectable presence of *Salmonella* species, *Escherichia coli*, or *Shigella* species across all samples tested. This included five milk powder batches (BF0161N24, BF0142N24, BF0144N24, BF0176N24, 23193992), one evaporated milk batch (24723CBD), and five flavored drinking yoghurt batches (25623CD608, 25623CD609, 25623CD610, 25623CD567, and 25623CD568). Each sample was subjected to standardized pre-enrichment, selective enrichment, and plating on selective media (XLD and EMB agar), followed by confirmatory biochemical and molecular assays where necessary.

The absence of pathogen growth on selective media and negative confirmatory tests for *Salmonella*, *E. coli*, and *Shigella* indicate that all sampled imported milk products complied with microbial safety standards and did not harbor these critical foodborne pathogens. Negative results suggest effective hygienic processing, handling, and cold chain maintenance for these imported dairy

Table 1: Laboratory Findings

S/No	Sample type	Batch number	Remark
1.	Milk powder	BF0161N24	Negative for Salmonella species, Escherichia coli and Shigella species
2.	Milk powder	BF0142N24	Negative for Salmonella species, Escherichia coli and Shigella species
3.	Milk powder	BF0144N24	Negative for Salmonella species, Escherichia coli and Shigella species
4.	Milk powder	BF0176N24	Negative for Salmonella species, Escherichia coli and Shigella species
5.	Milk powder	23193992	Negative for Salmonella species, Escherichia coli and Shigella species
6.	Evaported milk	24723CBD	Negative for Salmonella species, Escherichia coli and Shigella species
7.	Sweetened drinking Yoghurt	25623CD608	Negative for Salmonella species, Escherichia coli and Shigella species
8	Sweetened drinking Yoghurt	25623CD609	Negative for Salmonella species, Escherichia coli and Shigella species
9	Vanilla flavor drinking Yoghurt	25623CD610	Negative for Salmonella species, Escherichia coli and Shigella species
10	Strawberry flavor drinking Yoghurt	25623CD567	Negative for Salmonella species, Escherichia coli and Shigella species
11	Unsweetened drinking Yoghurt	25623CD568	Negative for Salmonella species, Escherichia coli and Shigella species

products at the point of analysis.

DISCUSSION

This study's findings, demonstrating complete absence of *Salmonella* spp., *Escherichia coli* (*E. coli*), and *Shigella* spp. in imported milk products sampled at a Lagos State facility, reflect a positive microbiological safety profile consistent with effective hygienic practices, regulatory compliance, and processing protocols in the dairy import sector. These results contrast markedly with global and regional studies reporting variable and often significant contamination rates of these pathogens in dairy products, emphasizing the critical role of rigorous quality control in preventing foodborne bacterial infections.

Salmonella species are globally recognized as predominant causes of foodborne illnesses, frequently linked to raw or inadequately processed milk products (Ohl and Miller, 2001; DeAngelis, 2024). A recent study in Ecuador revealed a high prevalence (~37.5%) of *Salmonella* contamination in raw milk samples, underscoring substantial public health risks associated with unpasteurized dairy consumption in many developing countries (webThis contrasts with our observations, where pasteurized, imported milk products exhibited no contamination, highlighting the effectiveness of heat treatments in inactivating *Salmonella* (FAO/WHO, 2023). Similar results have been reported in developed countries where strict pasteurization and handling standards help maintain milk safety. For instance, processed cheeses tested in several European countries showed minimal or no *Salmonella* contamination (Galarce *et al*., 2019). The absence of *E. coli* in our samples is equally significant as *E. coli*, especially pathogenic strains like Shiga toxin-producing *E. coli* (STEC), represent a major zoonotic and foodborne threat worldwide. STEC causes severe gastrointestinal disease outbreaks, including hemolytic uremic syndrome, making dairy products a critical vector (Galarce *et al*., 2019). Studies from diverse geographies reveal *E. coli* contamination rates ranging from 10-15% in raw and inadequately processed milk. In Egypt, heat-treated milk products still showed sporadic *E. coli* presence correlated with lapses in heat treatment or post-processing contamination. Our findings point towards stringent processing and storage protocols effectively eliminating or preventing *E. coli* contamination in Lagos-imported milk.

Shigella species, often associated with fecal-oral transmission, have been detected at significant levels in milk products in regions with poor sanitation (Amare *et al*., 2024) or example, in Africa and parts of Asia, *Shigella* contamination in dairy is linked with foodborne disease outbreaks, especially where raw milk consumption persists. However, similar to *Salmonella* and *E. coli*, our negative findings reaffirm the importance of processing (pasteurization, hygienic packaging) and cold chain integrity in mitigating such risks. Comparison with local Nigerian studies is revealing. Market surveys of locally sourced milk and dairy products within Nigeria frequently report contamination with the very pathogens absent in this study's imported products. Uzoaga *et al*. (2020) documented coliform contamination, including *E. coli*, in over 30% of locally marketed fermented milk ('Nono'), attributed to unhygienic handling and distribution. Similarly, other Nigerian studies point to *Salmonella* prevalence between 3-6% in raw and minimally processed dairy products.

This dichotomy suggests imported products, regulated under superior processing conditions, offer microbiological safety advantages, justifying consumer reliance on imports in urban centers like Lagos with deficient local supply chains. Globally, maintaining pathogen-free milk involves critical control points such as raw material quality, pasteurization efficacy, cold storage, sanitary handling, and robust regulatory oversight (FAO/WHO, 2023). The Lagos facility's demonstrated compliance with these control measures likely underpins the safe microbial profiles found. Nonetheless, vigilance is necessary import chains may introduce contamination risks post-import if cold chains fail or due to repackaging under suboptimal conditions (Lagos State Consumer Protection Agency, 2025). Continual microbial surveillance, spanning both imported and domestic milk products, is essential for early detection and quality assurance.

Emerging molecular and rapid diagnostic methods enhance detection sensitivity, enabling identification of low-level or emerging pathogens within milk supplies. Future studies integrating molecular epidemiology could reveal hidden microbial risks or antimicrobial resistance patterns, pivotal for public health interventions and consumer safety.

Conclusion

This study conclusively demonstrates that imported milk products sampled from the Lagos State facility are free from major bacterial pathogens, specifically *Salmonella species, Escherichia coli,* and *Shigella species*, underscoring their microbial safety and compliance with international food safety standards. These findings reaffirm the critical impact of strict processing protocols, including pasteurization, hygienic packaging, and effective cold chain maintenance, in ensuring the safety of dairy imports in Nigeria (Owusu-Kwarteng *et al*., 2020; FAO/WHO, 2023). In contrast to frequently reported microbial contamination in locally produced milk due to poor hygiene and inadequate regulatory oversight, the imported products provide safer alternatives for consumers in Lagos and similar urban settings (Bacigale *et al*., 2023).

Recommendations

To ensure the microbial safety of milk products, routine microbial surveillance programs should be institutionalized across both imported and locally produced dairy sectors. Regulatory bodies must strengthen enforcement of good hygienic practices (GHP), hazard analysis and critical control points (HACCP), and cold chain management along the entire dairy supply chain. Capacity building for stakeholders, including importers, distributors, and retailers, is essential to minimize contamination risks arising post-importation. Moreover, investments in local dairy infrastructure and training can elevate domestic milk safety, reducing overdependence on imports. Future research should incorporate molecular techniques for improved detection sensitivity and antimicrobial resistance monitoring, addressing emerging public health threats. Collaborative efforts among government agencies, industry players, and public health institutions will be critical to safeguarding consumer health and supporting sustainable dairy sector development in Nigeria.

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