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RESEARCH ARTICLE

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PREVALENCE AND DISTRIBUTION OF MICROBIAL CONTAMINATION IN RAW MILK AND PROCESSED DAIRY PRODUCTS IN JOS METROPOLIS

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ABSTRACT

The study investigates the microbial contamination of dairy products collected from four locations within Jos Metropolis;Tina Junction, FarinGada, Terminus, and Katako. A total of 200 dairy samples, including raw milk, Nono(fermented milk), Cheese, and Yoghurt, were aseptically collected and analyzed using standard microbiological methods. The results revealed significant variations in bacterial prevalence across locations and product types. Bacillus spp.

KEYWORDS

Farin Gada, Terminus, and Katako

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The study investigates the microbial contamination of dairy products collected from four locations within Jos Metropolis;Tina Junction, FarinGada, Terminus, and Katako. A total of 200 dairy samples, including raw milk, Nono(fermented milk), Cheese, and Yoghurt, were aseptically collected and analyzed using standard microbiological methods. The results revealed significant variations in bacterial prevalence across locations and product types. Bacillus spp. was the most frequently isolated bacterium; it was detected in 144 samples (72.0%), with the highest prevalence in raw milk (94.0%) and nono (92.0%). Mycobacterium bovis (M. bovis) was detected exclusively in raw milk (6.0%), indicating a potential risk of zoonotic transmission through unpasteurized dairy. Processed dairy products had a higher occurrence of yeast cells (13.2%), Micrococcus (2.8%), and Staphylococcus (10.4%), suggesting contamination may have occurred during processing and or storage. Among sampling locations, FarinGada and Katako had the highest microbial prevalence of 92.0% and 82.0%, respectively, while Tina Junction and Terminus recorded lower contamination levels (60.0% each). Raw milk had prevalence of 34.7% compared to processed dairy products (94.0%), it was concluded that , raw milk poses a significant risk of microbial contamination, while processed dairy products are susceptible to post-processing contamination. Given the high prevalence of Bacillus spp. (72.0%) and the presence of M. bovis in raw milk, all raw dairy products should undergo pasteurization or other heat treatments before consumption to eliminate harmful pathogens are recommended.

Introduction:-

The presence of pathogenic bacteria such as Listeria monocytogenes, Escherichia coli, Salmonella spp., and Staphylococcus aureus in raw and processed dairy products is a global public health concern, especially in developing regions with weak regulatory enforcement (Koskiet al., 2022). Raw milk's high nutrient content and neutral pH make it an ideal medium for microbial growth, and contamination can occur at any stage production, handling, storage, or transportation (Velázquez-Ordoñezet al., 2019; Penget al., 2023).Sources of contamination include poor farm hygiene, mastitis in animals, contaminated water, and improper handling practices (Adamskiet al., 2023). Additionally, failures in cold chain logistics can facilitate microbial proliferation (Praçaet al., 2023). Penget al. (2023) reported that 9.89% of raw milk samples exceeded safe aerobic plate counts, with over 54% containing aerobic Bacillus spp. and 36.18% exhibiting high alkaline phosphatase activity indicators of poor hygiene.Even post-processing techniques like pasteurization may not eliminate all pathogens. Spores from Bacillusand Clostridium spp. can survive heat treatment and contaminate products during packaging and distribution (Mariam, 2021). Koskiet al. (2022) found a link between unpasteurized milk availability and foodborne outbreaks in the U.S., while Praçaet al. (2023) detected L. monocytogenes and E. coli in raw milk cheese samples in Portugal.These pathogens pose serious health risks E. coli (especially STEC) can cause hemorrhagic colitis, Listeria can lead to miscarriage or death in vulnerable individuals, Salmonella causes gastroenteritis, and S. aureus produces heat-resistant enterotoxins (Adamskiet al., 2023; Praçaet al., 2023). The emergence of antimicrobial resistance further complicates the issue.Addressing contamination requires good agricultural practices (GAPs), including farm hygiene, animal health monitoring, and proper milking procedures. Processing plants must enforce pasteurization, prevent post-processing contamination, and maintain the cold chain. Advanced diagnostics such as PCR and genome sequencing are crucial for early detection (Martin et al., 2023).

Materials and Methods:-

Study Area

The study was conducted in Jos, the capital of Plateau State in North Central Nigeria. Plateau State spans approximately 26,899 km² and is home to about three million people (National Population Commission, 2006). Located between latitudes 08°24'N and longitudes 008°32'–010°38'E, the state is named after the Jos Plateau a high-altitude region marked by unique rock formations, extensive grasslands, and elevations ranging from 1,200 m to 1,829 m at Shere Hills.The area's history of tin and columbite mining has shaped its landscape, leaving behind gorges and artificial lakes. Due to its elevation, Plateau State experiences a near-temperate climate, with average temperatures between 13°C and 22°C. The coldest months occur between December and February, while March and April are the hottest. Annual rainfall averages 131.75–146 cm, peaking in July and August.Jos' cooler climate contributes to lower incidences of certain tropical diseases, such as malaria. The Plateau also functions as a major watershed, giving rise to key rivers in northern Nigeria, including the Kaduna, Gongola, Hadejia, and Yobe Rivers.

Sample Collection and Distribution

A total of 200 dairy product samples were collected from four major locations within Jos Metropolis Tina Junction, FarinGada, Terminus, and Katakowith each location contributing 50 samples to ensure even distribution. The dairy products sampled included raw milk, nono(a traditional fermented milk), cheese, and yoghurt, with 50 samples collected for each product type.The sample size was determined based on resource availability, feasibility, and the need for statistical reliability in assessing the microbiological quality and diversity of dairy products sold in the area. Samples were aseptically collected into sterile containers, appropriately labeled, and immediately transported in ice-cooled boxes to the laboratory for microbiological analysis.

Bacteriological Analysis

For microbiological evaluation, 50 mL of raw milk and 10 grams of each processed dairy product (nono, cheese, and yoghurt) were aseptically collected into sterile containers. The samples were immediately transported under chilled conditions (maintained at 4°C) to the National Veterinary Research Institute (NVRI) laboratory in Jos for bacteriological analysis. All procedures followed standard microbiological protocols to ensure the accuracy and reliability of results.

ISOLATION OF BACILLUS SPP.

Samples were cultured on Nutrient Agar (NA) and incubated at 37°C for 24 to 48 hours to isolate Bacillus species. Colonies displaying typical Bacillus morphology such as large, rough, irregular edges and opaque appearance were further subjected to

Gram staining. Biochemical confirmation was performed using catalase and oxidase tests to distinguish Bacillus from other Gram-positive spore-formers.

DETECTION OF MY COBACTERIUM BOVIS

Detection of Mycobacterium bovis was conducted using Ziehl-Neelsen staining to identify acid-fast bacilli. Samples that tested positive for acid-fast organisms were further confirmed through polymerase chain reaction (PCR)-based identification to ensure specificity and accuracy of M. bovis detection.

Isolation of Yeast, **Micrococcus**, and **Staphylococcus** spp.Yeast cells were isolated using Sabouraud Dextrose Agar (SDA) and incubated at 25°C for 48 to 72 hours. Colonies with yeast-like morphology were subjected to microscopic examination for confirmation.

Micrococcus and Staphylococcus species were isolated using Mannitol Salt Agar (MSA), which supports the selective growth of salt-tolerant organisms. Presumptive colonies were further characterized using a series of biochemical tests, including coagulase, catalase, and sugar fermentation assays, to differentiate and identify specific bacterial species.

DATA ANALYSIS

The prevalence of bacterial contamination was determined as percentages and presented in tables. The data were statistically analyzed using descriptive statistics (percentages and frequency distributions) to compare bacterial contamination across sampling locations and dairy product types.

PREVALENCE AND DISTRIBUTION OF MICROBIAL CONTAMINATION BY LOCATION

The study revealed notable variations in microbial contamination across sampling sites, largely influenced by handling, processing, and storage practices. Bacillus species were the most frequently isolated organisms, with an overall prevalence of 72.0%, particularly high in FarinGada (88.0%) and Katako (80.0%). This aligns with Edema and Akingbade (2007), who reported a high presence of spore-forming bacteria in dairy products, often linked to poor hygiene and environmental exposure.Mycobacterium bovis was detected in only 1.5% of samples, found exclusively in FarinGada (4.0%) and Katako (2.0%), indicating sporadic occurrence likely tied to localized handling conditions. The absence of Yeast, Micrococcus, and Staphylococcus spp. suggests relatively good sanitary practices in preventing contamination by these organisms.These results are consistent with Attahet al. (2021) and Anagbosoet al. (2024), who emphasized that poor sanitation, improper storage, and inadequate post-milking hygiene significantly contribute to microbial contamination. The findings reinforce the need for improved hygiene protocols, better handling practices, and continuous microbial monitoring in milk production and distribution systems.

Table 1: Prevalence of Microbial Contamination and Distribution **by Sampling Location**

Sampling Location	**Total Samples Collected**	**Bacillus**	**M. bovis**	**Yeast Cell**	**Micrococcus**	**Staphylococcus**	**Overall Prevalence (%)**
Tina Junction	50	30(60.0)	0(0.00)	0(0.00)	0(0.00)	0(0.00)	60.0
FarinGada	50	44(80.0)	2(4.0)	0(0.00)	0(0.00)	0(0.00)	92.0
Terminus	50	30(60.0)	0.00)	0(0.00)	0(0.00)	0(0.00)	60.0
Katako	50	40(80.0)	1(2.00)	0(0.00)	0(0.00)	0(0.00)	82.0
Total	**200**	**144 (72.0)**	**3(1.50)**	**0(0.00)**	**0(0.00)**	**0(0.00)**	**73.5**

PREVALENCE AND DISTRIBUTION OF MICROBIAL CONTAMINATION IN RAW MILK AND ITS PRODUCTS

The study findings are consistent with existing literature on microbial contamination in dairy products. Bacillus spp. showed the highest prevalence in raw milk (94.0%), confirming their widespread occurrence and resistance to pasteurization, as reported by Tan et al. (2020). The exclusive detection of Mycobacterium bovis in raw milk (6.0%) reinforces concerns about consuming unpasteurized milk and supports prior findings on its health risks (Eltokhyet al., 2021).Yeast cells were found in fermented products nono (8.0%), cheese (12.0%), and yoghurt (18.0%) indicating the influence of fermentation on yeast growth. While generally sensitive to thermal and pressure treatments, some heat-resistant molds can survive, posing spoilage and safety risks (Pal et al., 2016).The presence of Staphylococcus spp. in yoghurt (30.0%) suggests possible post-processing contamination, likely due to inadequate hygiene during handling and storage. This aligns with Agarwalet al. (2012), who reported similar contamination patterns in dairy products linked to poor sanitary conditions. These findings emphasize the importance of strict hygiene and pasteurization to ensure dairy safety.

Table 2: Prevalence of Microbial Contamination and Distribution **in Raw Milk and its Products**

Sample Type	**Total Samples Collected**	**Bacillus (%)**	**M. bovis (%)**	**Yeast Cell (%)**	**Micrococcus (%)**	**Staphylococcus (%)**
Raw Milk	50	47 (94.00)	3 (6.00)	0 (0.00)	0 (0.00)	0 (0.00)
Nono	50	46 (92.00)	0 (0.00)	4 (8.00)	0 (0.00)	0 (0.00)
Cheese	50	29 (58.00)	0 (0.00)	6 (12.00)	4 (8.00)	0 (0.00)
Yoghurt	50	22 (44.00)	0 (0.00)	9 (18.00)	0 (0.00)	15 (30.00)
Total	**200**	**144 (72.00)**	**3 (1.50)**	**19(9.50)**	**4(2.00)**	**15(7.50)**

COMPARISON OF MICROBIAL CONTAMINATION IN RAW AND PROCESSED DAIRY PRODUCTS

The study revealed a higher prevalence of Bacillus isolates in processed dairy products (67.4%) compared to raw milk (32.6%), suggesting that while pasteurization reduces many pathogens, it does not eliminate heat-resistant Bacillus spp. This supports findings by Ledenbach and Marshall (2009) and Pal et al. (2016), who noted the ability of Bacillus spores to survive pasteurization and germinate under favorable storage or handling conditions.Mycobacterium bovis was exclusively detected in raw milk (2.1%), underscoring the health risks of consuming unpasteurized milk. Its absence in processed dairy highlights the effectiveness of pasteurization in eliminating zoonotic pathogens (Li, 2022; Kahlaet al., 2011).The detection of yeast (13.2%) and Micrococcus (2.8%) mainly in processed products suggests contamination during fermentation or post-processing stages. Yobouetet al. (2014) reported similar findings, emphasizing the vulnerability of dairy products to contamination during handling and packaging.The presence of Staphylococcus spp. (10.4%) particularly in yoghurt points to post-pasteurization contamination, likely linked to inadequate sanitation. Previous studies by Svenssonet al. (2000) and Collins et al. (2022) have shown that poor hygiene and contaminated equipment in dairy plants can facilitate the persistence and spread of such bacteria in processed products.These findings reinforce the need for comprehensive hygiene controls throughout dairy processing to prevent contamination, especially by heat-resistant and post-processing-introduced microbes.

Table 3 Comparison of Microbial Contamination and Distribution in Raw and Processed Dairy Products

Dairy Category	**Bacillus**	**M. bovis**	**Yeast Cell**	**Micrococcus**	**Staphylococcus**	**Overall Prevalence (%)**
Raw Milk	47(32.6)	3(2.10)	0(0.00)	0(0.00)	0(0.00)	34.7
Processed Dairy						

Nono, Cheese and Yoghurt	97(67.4)	0(0.00)	19(13.2)	4(2.80)	15(10.4)	94.0
Total	**144(72.0)**	**3(1.5)**	**19(9.50)**	**4(2.00)**	**15(7.50)**	**73.5**

CONCLUSION AND RECOMMENDATIONS:-

This study highlights significant microbial contamination in dairy products across Jos Metropolis, with Bacillus spp. showing the highest prevalence (72.0%) and Mycobacterium bovis detected exclusively in raw milk (6.0%). Contamination levels varied by location and product type, with raw milk posing the greatest health risk due to its high microbial load. Processed dairy products showed evidence of secondary contamination particularly with yeast, Staphylococcus, and Micrococcus spp. likely introduced during fermentation or post-processing.

To mitigate these risks, several actions are recommended:

Mandatory pasteurization or heat treatment of all raw dairy products before consumption is essential to eliminate harmful pathogens.

Strict hygiene protocols should be enforced among dairy farmers and vendors, including proper milking, equipment sanitation, and safe handling practices.

Cold chain maintenance (≤4°C) must be prioritized across the dairy supply chain, supported by investments in refrigeration and temperature-controlled transportation.

Routine microbiological surveillance at production, processing, and retail levels is crucial to monitor contamination trends and enforce food safety standards.

Public health education campaigns should raise awareness about the risks of consuming unpasteurized dairy products, while regulatory agencies ensure vendor compliance with hygiene laws.

Support for small-scale producersthrough training, technical assistance, and access to equipment subsidies will promote safer production practices and reduce contamination risks.

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