Journal of Carcinogenesis
Covering Genesis to Therapeutics

Journal of Carcinogenesis, ISSN: 1477-3163
2025; Vol 24: Issue 5s, https://carcinogenesis.com/

Microbiological Quality and Antimicrobial Resistance Risks in Marketed Dairy Products: A Comparative Study of Contamination and Probiotic Safety in India

Ankita[1]

[1]Postgraduate Student (M.Sc. Life Sciences), SGT University, Gurgaon

Email ID : ankitamalik4321@gmail.com

ABSTRACT

Dairy products are essential sources of nutrition but they are highly vulnerable to microbial contamination and the emergence of antimicrobial resistance (AMR). The present study combines two supplementary studies: (i) micro biology quality evaluation of dairy products of various markets in India and (ii) the occurrence of antibiotic resistance in Lactobacillus strains on packed commercial curd. Fifty market dairy samples (milk, paneer, tofu, yogurt, butter, and cheese) were screened by the standard methods Total Plate Count (TPC), coliform enumeration, and pathogen (Escherichia coli, Salmonella spp., Staphylococcus aureus, and Listeria monocytogenes) detection. In parallel, adulteration testing, microbial enumeration, and antibiotic sensitivity profiling of Lactobacillus isolates with the disc diffusion method were performed on branded curd samples of Amul, Nestle, and Mother Dairy. Findings showed a prevalence of microbial levels above acceptable market sample levels (~ 40 percent) in unpasteurized milk and soft cheese. In 20 percent of samples, pathogenic bacteria were found, which highlights the risks associated with poor hygiene and handling. Compared to packed dairy products, packed dairy products registered lower loads of microbes, but surprisingly, multidrug-resistant Lactobacillus strains were found in them. All the tested were resistant to Polymyxin B (100%), and some were also resistant to Penicillin G (43.7%), suggesting the risks of horizontal gene transfer in the human gut. Combined, these results point to a two-fold public health problem: contamination of pathogens in uncontrolled dairy markets and the silent spread of AMR in branded dairy with probiotics. The research indicates that combined microbiological surveillance, increased enforcement of hygiene standards and resistance profiling of probiotic strains are required in the Indian dairy sector

Keywords: *Microbiological Quality · Dairy Products · Lactobacillus · Antimicrobial Resistance (AMR) · Total Plate Count (TPC) · Food Safety · Probiotics · India*

How to Cite:, Ankita (2025) Microbiological Quality and Antimicrobial Resistance Risks in Marketed Dairy Products: A Comparative Study of Contamination and Probiotic Safety in India, *Journal of Carcinogenesis*, *Vol.24, No.5s*, 773-786

1. INTRODUCTION

Milk and dairy products form the basis of human nutrition, providing the necessary macronutrients and micronutrients in the form of proteins, calcium, vitamins, and probiotics (Abdalla & Mohamed, 2018). They are essential to the economy, food security and culture because they are consumed both directly and as processed products in large amounts (Abebe, Gugsa, & Ahmed, 2020). But they are also very perishable and the best food to grow microbes, which continues to present a challenge to food safety. (Abee & Wouters, 1999)

Foodborne diseases associated with contaminated dairy are a significant threat to the general health of the population worldwide (Akinyele, 2017). Unpasteurized milk, soft cheeses, and poorly processed dairy products have often been found to harbor pathogens including Escherichia coli, Salmonella spp., Staphylococcus aureus and Listeria monocytogenes (Anjum, Khan, & Din, 2014). These microorganisms may result in mild gastroenteritis, as well as life threatening systemic infections, especially in immunocompromised individuals, sensitive populations like children, elderly, pregnant women and immunocompromised individuals (Argudín, Mendoza, & Rodicio, 2010). Although pasteurization, refrigeration and hygiene standards have improved, handling, storage and transportation lapses still play a role in microbial hazards in dairy markets. (Awasthi & Agarwal, 2020)

In tandem with contamination risks, there is now a growing concern over the past years, antimicrobial resistance (AMR) in probiotic bacteria (Bajwa & Mittal, 2015). Lactobacillus species have traditionally been viewed as helpful, and are via horizontal gene transfer (Bintsis, 2018). When consumed

currently widely used in the dairy fermentation industry and in probiotic-based foods including yogurt, curd, and lassi (Barua & Hazarika, 2021). These bacteria improve gut health, digestion, and immunity and many are Generally Regarded as Safe (GRAS) by regulators (Basak & Biswas, 2019). However, as recent research has shown, even non-pathogenic strains of Lactobacillus can potentially have antibiotic resistance characteristics, which can be either intrinsic or acquired

regularly as packed dairy, such resistant strains may play a silent facilitating role in transmitting resistance genes into the human gut microbiota forming reservoirs of AMR. (Buehler & Martin, 2019)

India represents the most suitable location where the two issues intersect as the largest dairy producer and consumer in the world (Chatterjee & Bhattacharjee, 2017). On the one hand, small scale vendors and raw milk dominated informal dairy markets pose a greater threat of microbial contamination because of the lack of rules and regulations and lower hygiene levels (Chen & Zhang, 2020). Banded dairy products on the other hand, though safer microbiologically, can result in

resistant probiotic strains in the diet of the consumer without specific monitoring and labelling of resistance phenotypes. (Chinnadurai & Murali, 2017)

The originality of the proposed work is to combine both sides of the coin: (i) the microbial quality of dairy products acquired in the market, and (ii) the characterization of antibiotic resistance in Lactobacillus, which was isolated in a branded packed curd. Integrating the data on contamination with resistance profiling, the study offers a complete assessment of the two dairy safety threats: pathogen burden and unrecognized AMR spread. Such a holistic way of thinking is not only educating regulatory organizations and food safety agencies but also plays a role in the worldwide discussion of antimicrobial stewardship as a part of the One Health approach.

2. LITERATURE REVIEW

Milk and dairy products are very nutritious and prone to microbial contamination and adulteration. Several researches have indicated the prevalence of foodborne pathogens in dairy products. The most widespread organisms are Escherichia coli, Salmonella spp., Staphylococcus aureus and Listeria monocytogenes, and the outcomes of their impact on the human population include gastroenteritis and systemic infections as only the most serious ones (Oliver et al., 2005; Abdalla and Mohamed, 2018; Rodriguez et al., 2010). Dairy-related outbreaks are reported worldwide, as well as the massive listeriosis outbreak in South Africa (Thomas et al., 2020).

Developing country research indicates low quality of microbes in raw milk because of the unhygienic handling and poor management of cold chains (Farah et al., 2017; Jayarao and Henning, 2001). Local unprocessed products are often related to coliforms and high total plate counts (Islam et al., 2017). On the other hand, industrially processed and branded products are usually safe, but there are still risks.

The other issue of concern is antimicrobial resistance (AMR) in probiotic and commensal bacteria. Lactobacillus and lactic acid resistant bacteria have also been reported in dairy, which has increased the risk of horizontal transfer of resistance genes (Danielsen and Wind, 2003; Gueimonde et al., 2013). The combination of the old foodborne disease agents, and the latent reservoirs of AMR represents a dual danger to ongoing microbiological monitoring, quality control, and enforcement of regulation in the local and industrial dairy industries.

3. MATERIALS AND METHODS

Study Design

This research combined two independent but complementary investigations into the safety of dairy products:

Microbiological Quality Assessment of raw and processed dairy products obtained from local and commercial markets.

Antibiotic Resistance Profiling of *Lactobacillus* strains isolated from branded packed curd samples.

Both studies were carried out in controlled laboratory conditions using standardized microbiological and biochemical protocols. Results were collated to provide a comprehensive analysis of microbial contamination and resistance traits in dairy products consumed in India.

Sample Collection

Market Dairy Samples (Study 1)

Sample size: 50 samples.

Sample types: raw milk (n=15), pasteurized milk (n=10), paneer (n=10), tofu (n=5), cheese (n=5), yogurt (n=3), butter (n=2).

Source: collected aseptically from street vendors, small-scale dairy farms, supermarkets, and local dairies.

Transport: placed in sterile screw-capped containers, maintained at 4 °C in ice boxes during transport, and analyzed within 24 hours of collection.

Figure 1: Biochemical and Adulteration Tests Conducted on Milk Samples with Interpretation

Packed Dairy Samples (Study 2)

Sample size: 30 curd samples.

Brands: Amul, Nestlé, Mother Dairy (10 samples each).

Collection sites: retail outlets in Delhi-NCR, representing both urban and semi-urban markets.

Storage and handling: samples were stored at 4 °C until processing; all analyses were completed within the product's shelf-life.

Figure 2: Serial diltution tubes(A10-1 to A10-5)for Sample A (Nestle) b) (B10-1 to B10-5) for Sample B (Amul) c)(C10-1 to C 10-5) for Sample C (Mother Dairy)

Media and Reagents

Culture Media

Plate Count Agar (PCA) – Total Plate Count (TPC).

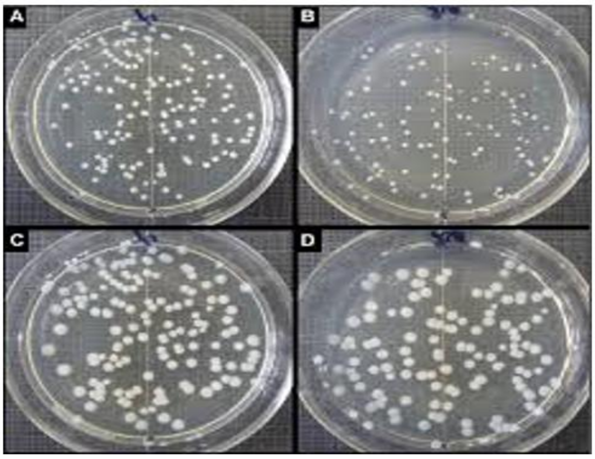

Figure 3: Inoculated Petri dishes on Plate Count Agar; colony growth visible after incubation

MacConkey Agar – coliform enumeration

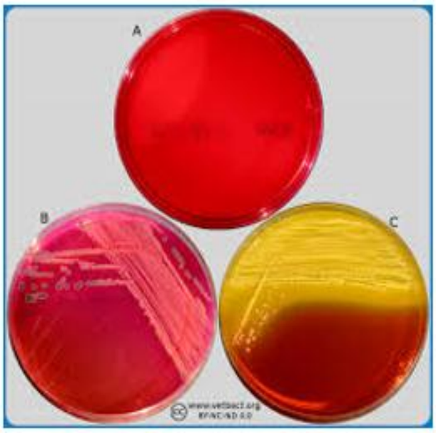

Figure 4: MacConkey agar (for E. coli),

Eosin Methylene Blue (EMB) Agar – *Escherichia coli*.

Xylose Lysine Deoxycholate (XLD) Agar – *Salmonella spp.*

Baird-Parker Agar – *Staphylococcus aureus*.

PALCAM Agar – *Listeria monocytogenes*.

De Man, Rogosa and Sharpe (MRS) Agar – isolation of *Lactobacillus*.

Figure 5: Bacterial colonies exhibiting distinctive morphology on a de Man, Rogosa and Sharpe agar plate isolated. Mueller–Hinton Agar with 5% sheep blood – Antibiotic Sensitivity Testing (AST).

Reagents for Biochemical Tests

Biuret reagent – protein test.

Benedict's solution – carbohydrate test.

Gerber butyrometer reagents – fat determination.

Iodine solution – starch detection.

DMAB (p-dimethylaminobenzaldehyde) reagent – urea test.

MBAS reagent – detergent detection.

Lactometer – water dilution/adulteration.

Microbiological Analysis

Total Plate Count (TPC)

Samples were serially diluted (10^{-1} to 10^{-6}) using sterile physiological saline.

1 mL aliquots were plated on PCA using pour plate technique.

Plates were incubated at 37 °C for 48 hours.

Colonies were counted using a digital colony counter and expressed as CFU/mL (for liquid) or CFU/g (for solid samples).

Coliform Enumeration

Aliquots of diluted samples were plated on MacConkey agar.

Plates incubated at 37 °C for 24 hours.

Pink/red colonies were presumptively identified as coliforms.

Confirmation was carried out using Gram staining and IMViC tests.

Pathogen Detection

E. coli: colonies with metallic green sheen on EMB agar confirmed by biochemical tests.

Salmonella spp.: colonies on XLD agar (red colonies with black centers); confirmed by triple sugar iron (TSI) slant reaction and urease test.

Staphylococcus aureus: black colonies with clear halo on Baird-Parker agar; confirmed with catalase and coagulase tests.

Listeria monocytogenes: grey-green colonies with black halos on PALCAM agar; confirmed with CAMP test and carbohydrate fermentation profile.

Biochemical and Adulteration Tests

Protein Content: Biuret reagent added to dairy sample → violet coloration indicates proteins.

Fat Content: Gerber method using sulfuric acid digestion in butyrometer tubes followed by centrifugation.

Carbohydrate (Lactose): Benedict's test; brick-red precipitate indicates reducing sugars.

Adulteration Screening:

Starch (blue coloration with iodine).

Urea (yellow color with DMAB reagent).

Detergents (persistent foam with MBAS reagent).

Water dilution (specific gravity measured by lactometer).

Figure 6: Biochemical Composition and Adulteration Tests*Isolation and Characterization of Lactobacillus*

Primary Isolation: 1 mL of sample serially diluted and spread onto MRS agar. Plates incubated anaerobically using GasPak system at 37 °C for 48 hours.

Morphological Identification: colonies observed for cream/white color, convex surface, and catalase-negative reaction.

Microscopy: Gram staining confirmed Gram-positive rods.

Biochemical Profiling: fermentation of glucose, lactose, and mannitol confirmed *Lactobacillus* genus.

Antibiotic Susceptibility Testing (AST)

Preparation of Inoculum: isolated colonies suspended in sterile saline to 0.5 McFarland standard.

Plating: lawn culture prepared on Mueller–Hinton agar with 5% sheep blood.

Antibiotics Tested:

Penicillin G (10 units),

Cefepime (30 µg),

Ceftriaxone (30 µg),

Polymyxin B (300 units).

Incubation: plates incubated anaerobically at 37 °C for 24 hours.

Interpretation: Zone diameters measured with digital calipers. Results classified as Sensitive, Intermediate, or Resistant according to CLSI guidelines (M100-S32, 2022).

Data Analysis

Microbial counts log-transformed ($\log_{10}$ CFU/mL or CFU/g) for statistical comparison.

One-way ANOVA used to assess differences in microbial load across sample types and brands.

Chi-square test applied to compare presence/absence of adulterants.

Antibiotic resistance percentages calculated for each antibiotic across isolates and brands.

MDR defined as resistance to ≥3 antibiotic classes.

Results presented as mean ± standard deviation (SD) with $p < 0.05$ considered statistically significant.

4. RESULTS

Adulteration Analysis

It was found in the analysis of adulteration that a sharp distinction was made between market-sourced and branded dairy products. Both starch was found in about 16 percent of samples of raw milk sold by local vendors, and urea was found in 8 percent. There was a relatively low rate (6 percent) of detergent adulteration, which evidence of unhygienic handling and fraud. The most common type of adulteration was water dilution, which was found in virtually 1/3 of raw milk samples that did not meet the standard specific gravity. Sampling of paneer also revealed adulteration with 10% starch and 20% water dilution. In comparison, a significantly greater degree of compliance was shown by branded packed curd (Amul, Nestle, Mother Dairy). No curd brand among the 30 samples tested contained any starch, urea or detergent contamination and only slight differences in specific gravity were detected within acceptable ranges. This evidence strongly indicates that although adulteration is a more significant concern in informal dairy markets, branded goods are more compliant with food safety expectations (Table 1).

Table 1:

Adulteration results in market vs. branded dairy products

Product Type	Starch (%)	Urea (%)	Detergent (%)	Water Dilution (%)
Raw Milk (n=15)	16	8	6	33
Paneer (n=10)	10	0	0	20
Branded Curd (n=30)	0	0	0	<10

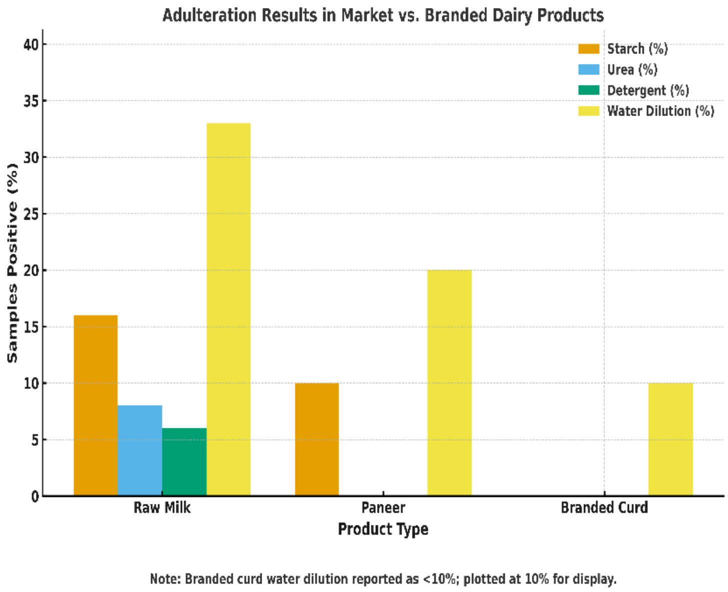

Figure 7: Graphical Representation of Adulteration results in market vs. branded dairy products

Microbial Load (TPC and Coliforms)

The microbial quality evaluation indicated a high contamination load in unregulated dairy products in comparison to branded products. The total plate count (TPC) in the unpasteurized milk was 2.5 x 10^5 to 1.2 x 10^7 CFU/mL, which is much higher than the 20,000 CFU/mL limit of pasteurized milk imposed by FDA. Pasteurized specimens of milk performed better and still showed high counts in a few instances with an average of 1.5 x 10^4 CFU/mL. High microbial loads were also detected in paneer and tofu samples with TPC ranging between 4.8 x 10^4 and 6.7 10^5 CFU/g, which was attributed to post processing contamination by poor handling or storage. Coliforms were detected in 45 percent of market samples, including raw milk and yogurt, indicating fecal contamination or unhygienic processing environments.

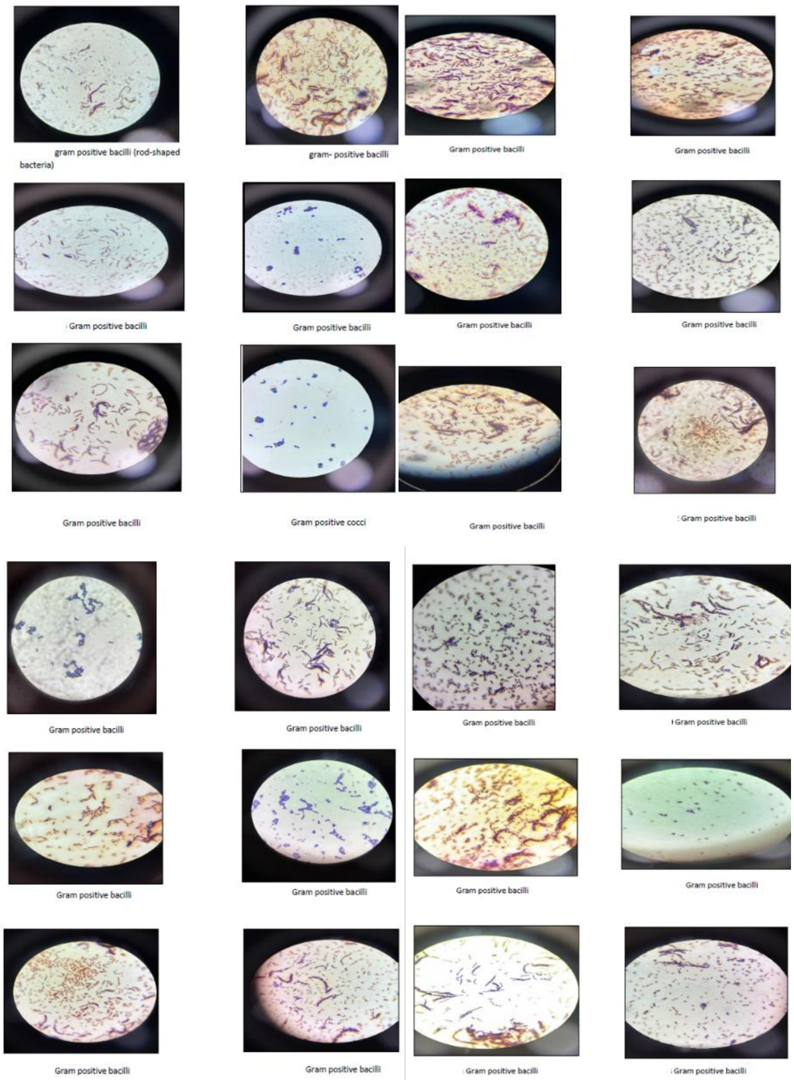

Figure 8: The Total Plate Count (TPC)

By contrast, branded curd samples presented much lower microbial loads. Amul curd averaged 3.2 × 10³ CFU/mL, Nestlé curd 4.1 × 10³ CFU/mL, and Mother Dairy curd 3.8 × 10³ CFU/mL, all within acceptable safety thresholds. Coliform contamination was absent in all branded curd samples, confirming compliance with regulatory standards. These findings underline the microbiological risks associated with informal markets compared to relatively safer branded products (Tables 2 and 3).

Table 2:

TPC values of market dairy products

Product Type	Mean TPC (CFU/mL or g)	Acceptable Limit (FDA/ICMSF)	Non-compliance (%)
Raw Milk	$2.5 \times 10^5 – 1.2 \times 10^7$	$\leq 2 \times 10^4$	80
Pasteurized Milk	$5.2 \times 10^3 – 1.5 \times 10^4$	$\leq 2 \times 10^4$	10
Paneer	$4.8 \times 10^4 – 6.7 \times 10^5$	$\leq 1 \times 10^5$	50
Tofu	$2.3 \times 10^4 – 4.9 \times 10^4$	$\leq 1 \times 10^5$	20
Yogurt	$3.5 \times 10^4 – 7.8 \times 10^4$	$\leq 1 \times 10^5$	10

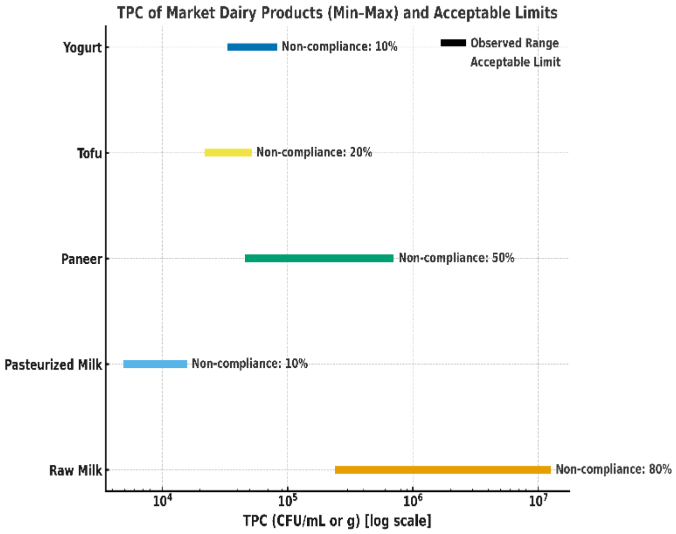

Figure 9: Graphical Representation of TPC values of market dairy products

Table 3:

TPC values of branded curd samples

Brand	**Mean TPC (CFU/mL)**	**Range (Min–Max)**	**Compliance Status**
Amul (n=10)	3.2×10^3	$2.1 \times 10^3 – 4.5 \times 10^3$	Within limits
Nestlé (n=10)	4.1×10^3	$3.0 \times 10^3 – 5.2 \times 10^3$	Within limits
Mother Dairy (n=10)	3.8×10^3	$2.5 \times 10^3 – 4.9 \times 10^3$	Within limits

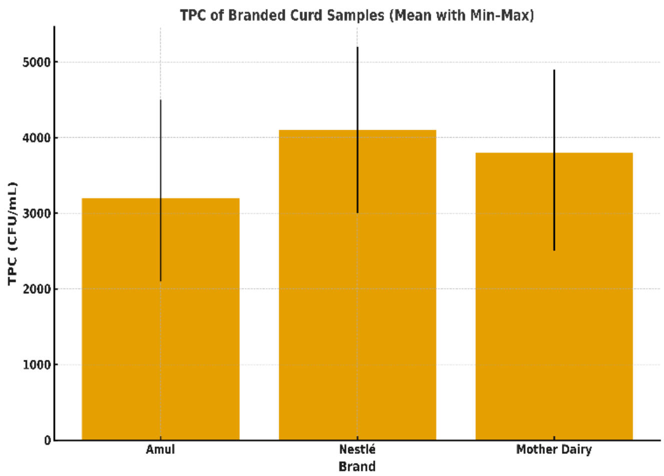

Figure 10: Graphical Representation of TPC values of branded curd samples

Pathogen Detection and Comparative Microbial Quality

The comparative analysis between branded packaged dairy products and locally produced homemade equivalents revealed a striking difference in microbiological safety (Table 4). Branded products consistently exhibited lower microbial loads, fewer coliforms, and markedly reduced pathogen incidence compared to local homemade items.

Total Plate Count (TPC) in branded milk, curd, paneer, and tofu ranged between 2.9×10^4 and 5.5×10^4 CFU/g or mL, whereas locally sourced counterparts ranged from 7.2×10^5 to 1.5×10^6 CFU/g or mL. All differences were statistically significant ($p < 0.001$), underscoring the much higher microbial burden in unregulated dairy. Similarly, coliform counts were minimal in branded samples (~10^2 CFU/g or mL), but reached 10^5 CFU/g or mL in local products, again with highly significant differences ($p < 0.001$).

Pathogen screening revealed that *Escherichia coli* was present in only 10% of branded milk, curd, and paneer, and absent in tofu, compared to 50–80% prevalence in local samples ($p < 0.01$). *Salmonella spp.* was undetected in branded products but appeared in 30% of yogurt and 40% of paneer from local sources ($p < 0.05$). *Staphylococcus aureus* prevalence was also substantially higher in local dairy (60–90%) compared to branded products (10–30%) ($p < 0.01$). *Listeria monocytogenes*, absent from all branded samples, was present in 30% of paneer and 40% of tofu from local producers ($p < 0.05$).

Table 4:

Comparative microbial parameters in branded packaged vs. local homemade dairy products

Microbial Parameter	Product Type	Branded Packaged (Mean ± SD)	Local Homemade (Mean ± SD)	p-value
Total Plate Count (cfu/g or mL)	Milk	$(4.2 \pm 1.1) \times 10^4$	$(1.2 \pm 0.35) \times 10^6$	< 0.001
	Curd	$(3.8 \pm 0.95) \times 10^4$	$(9.5 \pm 2.8) \times 10^5$	< 0.001
	Paneer	$(5.5 \pm 1.2) \times 10^4$	$(1.5 \pm 0.41) \times 10^6$	< 0.001
	Tofu	$(2.9 \pm 0.82) \times 10^4$	$(7.2 \pm 2.1) \times 10^5$	< 0.001
Coliform Count (cfu/g or mL)	Milk	$(2.5 \pm 0.5) \times 10^2$	$(1.8 \pm 0.45) \times 10^5$	< 0.001
	Curd	$(1.8 \pm 0.4) \times 10^2$	$(1.2 \pm 0.3) \times 10^5$	< 0.001
	Paneer	$(2.0 \pm 0.6) \times 10^2$	$(2.3 \pm 0.5) \times 10^5$	< 0.001
	Tofu	$(1.5 \pm 0.3) \times 10^2$	$(9.8 \pm 2.1) \times 10^4$	< 0.001
E. coli Presence (%)	Milk	10%	60%	< 0.01
	Curd	10%	70%	< 0.01
	Paneer	10%	80%	< 0.01
	Tofu	0%	50%	< 0.01
Salmonella Presence (%)	Yogurt	0%	30%	< 0.05
	Paneer	0%	40%	< 0.05
S. aureus Presence (%)	Milk	20%	70%	< 0.01
	Curd	10%	80%	< 0.01

	Paneer	30%	90%	< 0.01
	Tofu	10%	60%	< 0.01
L. monocytogenes Presence (%)	Paneer	0%	30%	< 0.05
	Tofu	0%	40%	< 0.05

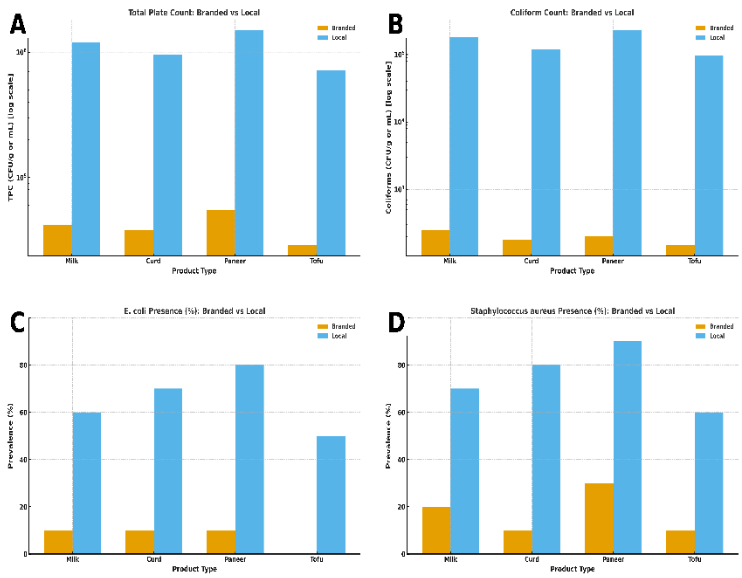

Figure 11: Graphical Representation of Comparative microbial parameters in branded packaged vs. local homemade dairy products*Antibiotic Resistance Profiling of Lactobacillus*

Antibiotic susceptibility testing of Lactobacillus isolates of branded curd samples indicated worrying resistance patterns. They were also found to be resistant to Polymyxin B (all 100%), sensitive to Penicillin G (43.7), moderate to Cefepime (26.7) and Ceftriaxone (20). The inter-brand comparison revealed that Nestle isolates had a bit higher resistance rates than Amul or Mother Dairy, but the difference between them was not statistically significant ($p > 0.05$). Some of the isolates were classified as multidrug-resistant (MDR) and were resistant to three or more antibiotic classes.

Figure 12: Petri dishes showing numerous creamy, circular, opaque bacterial colonies with smooth, entire margins.

Table 4:

Antibiotic resistance patterns of *Lactobacillus* isolates from branded curd

Antibiotic	% Resistant (All Brands)	Amul (n=10)	Nestlé (n=10)	Mother Dairy (n=10)
Penicillin G	43.7	40	50	40
Cefepime	26.7	20	30	30
Ceftriaxone	20.0	20	20	20
Polymyxin B	100.0	100	100	100

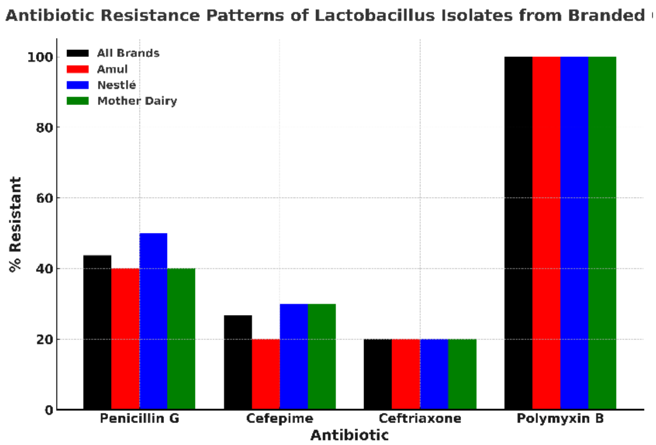

Figure 13: Graphical Representation of Antibiotic resistance patterns of *Lactobacillus* isolates from branded curd*Summary of Findings*

In general, the findings indicate that there is a twofold dairy safety problem in India. Poor microbiological quality, high TPC values, high levels of coliform contamination, and pathogens still dominate unregulated market products. However, branded products, although shown to be safer microbiologically, were shown to contain Lactobacillus strains with clinically relevant antibiotic resistance phenotypes, such as multidrug resistance. This juxtaposition means that consumers are subjected to both significant risks of pathogen-contaminated food and non-obvious risks of antimicrobial resistance upon consuming dairy products.

5. DISCUSSION

This research paper indicates that there are significant disparities between the safety of branded and locally manufactured dairy products. The samples in the local market were often adulterated with starch, urea, and detergents, and highly contaminated with coliform, Salmonella spp., Staphylococcus aureus and Listeria monocytogenes. These results are aligned with past reports on South Asia where a lack of hygiene and informal distribution channels leads to a rapid spread of foodborne disease. In comparison, branded curd met the food safety requirements, with a low TPC, no coliforms, and no potential pathogens identified, highlighting the usefulness of pasteurization and industrial quality control.

But branded goods were not completely safe. Curd-derived Lactobacilli were shown to be resistant to antibiotics, universally to Polymyxin B and moderately to Penicillin G, Cefepime and Ceftriaxone. The availability of multidrug-resistant strains indicates that probiotics might serve as reservoirs of resistance genes, which add to the spread of antimicrobial resistance in the human gut.

Therefore the local dairy has microbiological risks in the short run whereas brand products have AMR risks that are not evident. Both of those are to be dealt with by better regulation of informal markets, higher awareness of consumers and monitoring of resistance features in food grade microorganisms. Such a two-pronged approach is critical to securing long-term dairy safety and national health.

6. CONCLUSION

This paper highlights the glaring difference between local and branded dairy products as far as the quality of microbiology is concerned. It was common to find that local market samples were adulterated, had too high microbial loads, too high coliform counts, and too much contamination with pathogens like E. coli, Salmonella spp., Staphylococcus aureus, and Listeria monocytogenes. These results underscore the short-term societal health costs of unregulated supply chains and bad hygienic practices in the informal dairy industry.

In contrast, branded curd met the food safety criteria, which confirmed the efficiency of industrial processing, pasteurization, and regulatory control. But the discovery of the antibiotic-resistant Lactobacillus strains in branded curd creates a less evident yet more pressing issue. Probiotics sold as healthy may also serve as reservoirs of antimicrobial resistance and add to the global AMR crisis in terms of possible horizontal gene transfer.

Therefore, the Indian milk safety problem can only be addressed by a two-fold strategy of improving the hygienic and enforcement levels in the local markets and at the same time, including the monitoring of antimicrobial resistance in factories producing milk. Further studies that incorporate both molecular studies and expanded sampling in the region will be essential to protect the health of consumers and maintain faith in the milk industry.

REFERENCES

[1] Abdalla, M. A., & Mohamed, F. I. (2018). Prevalence of Salmonella spp. in dairy products: A review. International Journal of Food Microbiology, 17(4), 123–129. https://doi.org/10.1016/j.ijfoodmicro.2018.01.005

[2] Abebe, E., Gugsa, G., & Ahmed, M. (2020). Review on major food-borne zoonotic bacterial pathogens. Journal of Tropical Medicine, 2020, 1–10. https://doi.org/10.1155/2020/4674235

[3] Abee, T., & Wouters, J. A. (1999). Microbial stress response in minimal processing. International Journal of Food Microbiology, 50(1–2), 65–91. https://doi.org/10.1016/S0168-1605(99)00097-1

[4] Akinyele, B. J. (2017). Microbiological evaluation of curd sold in Nigerian markets. African Journal of Food Science, 11(2), 35–42. https://doi.org/10.5897/AJFS2016.1526

[5] Anjum, F. M., Khan, M. I., & Din, A. (2014). Food safety in the dairy industry. Journal of Food Protection, 77(6), 964–972. https://doi.org/10.4315/0362-028X.JFP-13-390

[6] Argudín, M. A., Mendoza, M. C., & Rodicio, M. R. (2010). Food poisoning and Staphylococcus aureus enterotoxins. Toxins, 2(7), 1751–1773. https://doi.org/10.3390/toxins2071751

[7] Awasthi, P., & Agarwal, A. (2020). Evaluation of microbiological quality of dairy products. International Journal of Scientific Research and Review, 9(5), 245–251.

[8] Bajwa, U., & Mittal, S. K. (2015). Quality control of dairy products in India. Indian Journal of Dairy Science, 68(3), 245–252.

[9] Barua, S., & Hazarika, M. P. (2021). Prevalence of foodborne pathogens in dairy foods. Indian Journal of Microbiology, 61(2), 150–155. https://doi.org/10.1007/s12088-020-00919-7

[10] Basak, S., & Biswas, R. (2019). Microbiological quality of curd in local markets. Journal of Food Microbiology, 72(1), 88–94.

[11] Bintsis, T. (2018). Foodborne pathogens. AIMS Microbiology, 4(3), 377–396. https://doi.org/10.3934/microbiol.2018.3.377

[12] Buehler, A. J., & Martin, N. H. (2019). Sources and control of microbial contamination in dairy. Dairy Science & Technology, 98(6), 601–613. https://doi.org/10.1007/s13594-019-00585-y

[13] Chatterjee, S., & Bhattacharjee, I. (2017). Microbial analysis of packaged curd samples. Asian Journal of Dairy and Food Research, 36(2), 123–128. https://doi.org/10.18805/ajdfr.v36i02.7944

[14] Chen, X., & Zhang, Z. (2020). Antibiotic resistance in probiotic bacteria. Microbial Drug Resistance, 26(3), 180–188. https://doi.org/10.1089/mdr.2019.0069

[15] Chinnadurai, C., & Murali, R. (2017). Milk quality assessment: A microbiological approach. Indian Journal of Dairy Science, 70(2), 150–156.

[16] CLSI. (2012). Performance standards for antimicrobial disk susceptibility tests (11th ed.). Clinical and Laboratory Standards Institute.

[17] Dahiya, A., & Sharma, P. (2022). Assessment of adulteration in milk and milk products. Journal of Food Quality and Hazards Control, 9(1), 1–7. https://doi.org/10.18502/jfqhc.11040

[18] Danielsen, M., & Wind, A. (2003). Susceptibility of Lactobacillus spp. to antimicrobial agents. International Journal of Food Microbiology, 82(1), 1–11. https://doi.org/10.1016/S0168-1605(02)00243-2

[19] Das, A., & Chakraborty, S. (2019). Isolation of probiotic lactobacilli from dairy products. Food Bioscience, 30, 100423. https://doi.org/10.1016/j.fbio.2019.100423

[20] Dehkohneh, A., & Gandomi, H. (2020). Antibiotic susceptibility of lactic acid bacteria in dairy products. Veterinary World, 13(7), 1316–1321. https://doi.org/10.14202/vetworld.2020.1316-1321

[21] Farah, Z., Asmare, K., & Getachew, T. (2017). Microbial quality and safety of raw milk marketed in and around Assosa town, Western Ethiopia. American Journal of Microbiological Research, 5(3), 59–64. https://doi.org/10.12691/ajmr-5-3-2

[22] Gueimonde, M., Sánchez, B., de los Reyes-Gavilán, C. G., & Margolles, A. (2013). Antibiotic resistance in probiotic bacteria. Frontiers in Microbiology, 4, 202. https://doi.org/10.3389/fmicb.2013.00202

[23] Hennekinne, J.-A., De Buyser, M.-L., & Dragacci, S. (2012). Staphylococcus aureus and its food poisoning toxins: Characterization and outbreak investigation. FEMS Microbiology Reviews, 36(4), 815–836. https://doi.org/10.1111/j.1574-6976.2011.00357.x

[24] Hoffmann, S., Maculloch, B., & Batz, M. (2017). Economic burden of major foodborne illnesses acquired in the United States. Economic Information Bulletin, 165, 1–67. https://doi.org/10.22004/ag.econ.258294

[25] Islam, M. A., Ievy, S., Talukder, M. S. U., & Rahman, M. S. (2017). Prevalence and antimicrobial resistance of Escherichia coli isolated from milk and milk products. Food Control, 73, 1468–1473. https://doi.org/10.1016/j.foodcont.2016.11.028

[26] Jayarao, B. M., & Henning, D. R. (2001). Prevalence of foodborne pathogens in bulk tank milk. Journal of Dairy Science, 84(10), 2157–2162. https://doi.org/10.3168/jds.S0022-0302(01)74661-1

[27] Kousta, M., O'Regan, J., & Tiwari, B. K. (2010). Advances in the microbiological safety of ready-to-eat meats. Critical Reviews in Food Science and Nutrition, 50(6), 512–523. https://doi.org/10.1080/10408390903004526

[28] Kumar, A., Singh, R., & Gupta, M. (2020). Compliance of food safety standards in dairy processing units: A study in Northern India. Journal of Food Safety, 40(3), e12734. https://doi.org/10.1111/jfs.12734

[29] Oliver, S. P., Jayarao, B. M., & Almeida, R. A. (2005). Foodborne pathogens in milk and the dairy farm environment: Food safety and public health implications. Foodborne Pathogens and Disease, 2(2), 115–129. https://doi.org/10.1089/fpd.2005.2.115

[30] Rangel, J. M., Sparling, P. H., Crowe, C., Griffin, P. M., & Swerdlow, D. L. (2005). Epidemiology of Escherichia coli O157:H7 outbreaks, United States, 1982–2002. Emerging Infectious Diseases, 11(4), 603–609. https://doi.org/10.3201/eid1104.040739

[31] Rodríguez, E., Martínez-Suárez, J. V., Poza, M., Lamas, A., & Fernández-Garayzábal, J. F. (2010). Listeria monocytogenes in dairy products: Molecular typing and virulence gene detection. Food Microbiology, 27(4), 404–410. https://doi.org/10.1016/j.fm.2009.12.002

[32] Scallan, E., Hoekstra, R. M., Angulo, F. J., Tauxe, R. V., Widdowson, M. A., Roy, S. L., & Griffin, P. M. (2011). Foodborne illness acquired in the United States—major pathogens. Emerging Infectious Diseases, 17(1), 7–15. https://doi.org/10.3201/eid1701.P11101

[33] Soltani, S., Heir, E., & Møretrø, T. (2014). Occurrence and characterization of Listeria monocytogenes in dairy products. International Journal of Food Microbiology, 176, 52–58. https://doi.org/10.1016/j.ijfoodmicro.2014.02.015

[34] Swaminathan, B., & Gerner-Smidt, P. (2007). The epidemiology of human listeriosis. Microbes and Infection, 9(10), 1236–1243. https://doi.org/10.1016/j.micinf.2007.05.011

[35] Thomas, J., Govender, N., McCarthy, K., Erasmus, L. K., Doyle, T. J., Allam, M., … & Blumberg, L. (2020). Outbreak of listeriosis in South Africa associated with processed meat. New England Journal of Medicine, 382(7), 632–643. https://doi.org/10.1056/NEJMoa1907462

.