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Research Article

Microbiological and Physicochemical Quality of Dairy Goat Milk in a Tropical Smallholder System: A Case Study of Padayo Goat Farm

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ABSTRACT

Goat milk is increasingly recognized as a functional food in developing countries because of its high nutritional value and digestibility. However, maintaining its microbiological safety and physicochemical stability remains challenging, particularly in smallholder systems under tropical conditions. This study evaluated the quality of dairy goat milk based on total plate count (TPC), pH, and alcohol stability at a smallholder farm in West Sumatra, Indonesia. Milk samples were collected from 16 lactating goats and analyzed using standard laboratory methods. The average TPC was 3.58×10^4 CFU/mL, well below the maximum permissible limit of 1×10^6 CFU/mL Indonesian and Thai Agricultural Standards. The mean pH value was 6.71 ± 0.01, indicating fresh milk conditions, while all samples exhibited negative alcohol test results, confirming protein stability and the absence of early spoilage. These findings demonstrate that high-quality milk can be produced in tropical smallholder systems when basic hygiene practices are properly implemented. This study provides empirical evidence supporting the role of smallholder dairy goat farms in ensuring food safety and sustainable dairy development in emerging economies.

Keywords: goat milk, microbiological quality, physicochemical, smallholder dairy, tropical environment

INTRODUCTION

Goat milk has gained increasing global attention as a functional dairy product owing to its high nutritional value, digestibility, and health-promoting properties. Compared to cow milk, goat milk contains smaller fat globules and a distinct protein structure that forms softer coagulates during digestion, facilitating faster gastric emptying and improved amino acid absorption (van Eijnatten et al., 2025). These characteristics make goat milk particularly suitable for individuals with digestive sensitivity and lactose intolerance (Nayik et al., 2022).

In addition to its nutritional advantages, goat milk is rich in essential components, such as medium-chain fatty acids, bioactive peptides, vitamins, and minerals, which contribute to its functional and therapeutic potential (Singh et al., 2021). These bioactive compounds have been associated with improved gut health, anti-inflammatory responses, and enhanced metabolic functions, particularly when processed into fermented dairy products (Guo et al., 2022; Illikoud et al., 2023). Consequently, the demand for goat milk has increased significantly in developing countries, including Indonesia, where rising public awareness of health and nutrition has influenced consumer preferences for alternative dairy products (Ratni et al., 2024a, 2024b).

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Ensuring the quality and safety of goat milk remains a critical challenge, particularly in smallholder farming systems, despite its increasing demand. In tropical environments, factors such as high ambient temperature and humidity can accelerate microbial growth and increase the risk of milk spoilage if proper handling practices are not implemented (Zhang et al., 2024). Additionally, traditional milking practices, including manual hand milking and the use of simple equipment, may increase the likelihood of contamination if hygiene is not strictly maintained (FAO and IDF, 2011).

Microbiological quality, commonly assessed through total plate count (TPC), serves as a key indicator of milk hygiene and safety. High TPC values are generally associated with poor sanitation during milking and improper postharvest handling (Susanty et al., 2025). Moreover, subclinical mastitis is a major concern in dairy goat production, as it can significantly increase the microbial load without visible clinical symptoms (Susanty et al., 2024). In addition to microbiological parameters, physicochemical indicators, such as pH and alcohol stability, are widely used to evaluate milk freshness and protein integrity, as they are sensitive to changes caused by microbial activity and early spoilage (Ratni et al., 2024c).

Furthermore, increasing concerns regarding milk adulteration and authenticity have emphasized the importance of quality control in dairy supply chains. Advanced analytical approaches, including omics-based biomarkers, have been developed to detect adulteration and ensure the authenticity of goat milk and its derivatives (Ait El Alia et al., 2026). These developments highlight the need for reliable baseline data on raw milk quality, particularly for emerging dairy production systems.

Although numerous studies have evaluated milk quality in intensive dairy systems, limited information is available on the microbiological and physicochemical qualities of goat milk produced under tropical smallholder conditions, particularly in Indonesia. This knowledge gap is important because smallholder farms represent a major component of the dairy sector in developing countries. However, empirical data linking the microbiological and physicochemical qualities of goat milk under tropical smallholder conditions remain limited, particularly in Indonesia, where traditional management systems dominate dairy production. This knowledge gap is critical because smallholder farms represent a major component of the dairy sector in developing countries.

Therefore, this study aimed to evaluate the microbiological and physicochemical qualities of dairy goat milk at the Padayo Goat Farm in West Sumatra based on total plate count (TPC), pH, and alcohol test parameters. These findings are expected to provide scientific evidence on the capability of smallholder dairy systems to produce safe and high-quality milk under traditional management conditions, thereby supporting sustainable dairy development and food safety in tropical regions.

MATERIAL AND METHODS

Research Location and Materials

This study was conducted at the Padayo Goat Farm in Indarung, Padang, West Sumatra, Indonesia. Laboratory analyses were performed at the Laboratory of Dairy Technology, Faculty of Animal Science, Universitas Andalas. Milk samples were collected individually from 16 lactating goats during morning milking. Each sample was handled separately to capture the variation among animals, and all laboratory analyses were performed in triplicate.

Sampling and Parameters

Milk samples were collected three times during the morning milking process, following standard hygienic protocols. The observed parameters were as follows:

1. Total Plate Count (TPC)
   TPC analysis was conducted using the standard plate count method to determine the number of viable bacteria in milk samples. The results were expressed as colony-forming units per mL (CFU/mL) (Ratni et al., 2024c).
2. pH Measurement
   The pH of the milk samples was measured using a digital pH meter after calibration. Measurements were conducted immediately after sample collection.
3. Alcohol Test
   An alcohol test was performed by mixing milk samples with a 70% alcohol solution in equal proportions. The mixture was gently shaken, and the presence or absence of coagulation was observed to assess milk stability. A positive result in the alcohol test was indicated by the formation of white flakes or clots due to protein coagulation, which adhered to the inner surface of the test tube. In contrast, a negative result was characterized by the absence of white particles or coagulation, indicating that the milk remained stable without visible protein precipitation (Dwitania & Swacita, 2013).

Data Analysis

Data were analyzed descriptively using the mean and standard deviation; however, variability among samples was also considered when interpreting the biological consistency.

RESULTS AND DISCUSSION

General Condition of the Farm

The Padayo Goat Farm is a smallholder dairy goat enterprise located in Indarung, Padang, West Sumatra, at an altitude of approximately 400 m above sea level. The farm operates under typical tropical environmental conditions, with an average ambient temperature of approximately 26°C. Dairy goats are raised primarily for fresh milk production, which is directly distributed to local consumers. The management system is relatively traditional, with most activities, including feeding, cleaning, and milking, performed manually.

A total of 149 goats were maintained at the farm, comprising several dairy breeds, including Peranakan Etawa, Jawarandu, Sapera, Saanen, and Anglo-Nubian. The presence of multiple breeds may contribute to the variability in milk production and composition. The animals were reared under a semi-intensive system using raised slatted-floor housing, with the floor positioned approximately 1.5 m above ground level to facilitate waste management and improve ventilation. Goats were grouped based on their physiological status, including bucks, lactating does, replacement stock, and kids. The housing system followed a head-to-head arrangement, allowing for efficient feed distribution and interaction.

The primary feed source for these animals is field grass, which is supplemented with concentrates derived from agro-industrial by-products, such as tofu and tempeh waste. This feeding strategy is designed to meet the dry matter requirements of the animals, and water is provided *ad libitum*. However, variability in feed quality and environmental conditions may influence milk composition and overall productivity.

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Milking was conducted manually twice daily, and milk was collected using simple containers. Although this method is widely used in smallholder systems, it is highly hygiene-dependent. Inadequate sanitation during milking may increase the risk of microbial contamination, thereby affecting milk quality.

Sixteen lactating goats were selected as milk samples in this study, representing different breeds, ages, parity, and lactation stages (Table 1). Most animals were in early lactation (months 1–2) and first parity, which may have influenced both the microbial load and physicochemical properties of milk. Environmental conditions in tropical regions, particularly high temperature and humidity, may also contribute to heat stress, which can indirectly affect milk quality. Therefore, farm management practices play a crucial role in maintaining animal welfare and milk safety.

Table 1. Characteristics of lactating dairy goats used as milk samples (n=16)

Parameter	Category	Number of Animals
Breed	Peranakan Etawa (PE)	5
	Sapera	7
	Anglo-Nubian	1
	Jawarandu	3
Age (years)	1 – 1.5	4
	2 – 2.5	6
	3 – 3.5	6
Parity	1	7
	2	6
	3	3
Lactation Month	1	7
	2	6
	3	2
	4	1

Milk Quality

The microbiological and physicochemical characteristics of goat milk are presented in Table 2. Overall, the results indicate that the milk produced at the Padayo Goat Farm meets the established quality standards, reflecting adequate management and hygiene practices under smallholder conditions.

Table 2. Total Plate Count (TPC), pH, and Alcohol Test of Goat Milk

Parameter	Unit	Mean ± SD	Standard	Description
Total Plate Count (TPC)	CFU/mL	$3.58 \times 10^4 \pm 0.82$	$\leq 1 \times 10^6$	Meets standard
pH	–	6.71 ± 0.01	6.3 – 6.8	Normal
Alcohol Test	–	Negative (–)	Negative	Stable

1. Total Plate Count

The average total plate count (TPC) obtained in this study was $3.58 \times 10^4 \pm 0.82$ CFU/mL, indicating a relatively low level of microbial contamination. This value is well below the maximum permissible limit of 1×10^6 CFU/mL established by the Indonesian National Standard (SNI

3141.1:2011) and from >10^5 to 2 × 10^5 CFU/mL (TAS 6006, 2008), confirming that the milk meets the microbiological quality requirements.

Low TPC values generally reflect effective sanitation during milking and proper postharvest handling. Microbial contamination of milk is influenced by multiple factors, including udder hygiene, cleanliness of milking equipment, environmental sanitation, and storage conditions. Poor hygiene practices may introduce contaminants that rapidly increase bacterial counts, thereby compromising the quality and safety of milk.

The relatively low TPC observed in this study may be attributed to prompt post-milking handling and minimal exposure to environmental contaminants. In tropical smallholder systems, rapid handling is particularly important to prevent bacterial proliferation at high ambient temperatures (Obayomi & Edo, 2025). These findings suggest that acceptable microbiological quality can be achieved using traditional management systems when basic hygiene practices are implemented consistently.

Maintaining low microbial levels is essential because raw milk can serve as a medium for the growth of foodborne pathogens. In addition, low bacterial loads are important for preserving product authenticity and preventing the adulteration of goat milk and its derivatives (Ait El Alia et al., 2026). Therefore, proper hygiene practices are crucial to ensuring the safety and quality of smallholder dairy products.

2. pH Value

The average pH value of the milk samples was 6.71 ± 0.01, which falls within the normal range of fresh goat milk (6.3–6.8). This indicated that the milk was fresh and had not undergone significant microbial fermentation. Milk pH is closely associated with microbial activity, particularly the conversion of lactose to lactic acid by bacteria, which leads to increased acidity. The stable pH observed in this study suggests that microbial growth was minimal and that milk-handling practices were adequate. The normal pH range observed in this study further supports the assumption that milk is derived from healthy udders with minimal inflammatory conditions (Susanty et al., 2025).

A stable pH is also essential for downstream processing, as it influences coagulation properties, shelf life, and overall product quality in dairy products such as yogurt and cheese. Goat milk is known to exhibit softer protein coagulation and contains higher levels of medium-chain fatty acids, such as C10 and C12, which contribute to its improved digestibility and nutritional value (Sharma, 2023; van Eijnatten et al., 2025).

Furthermore, maintaining a normal pH is crucial for the development of functional dairy products. Milk with stable physicochemical characteristics can be effectively processed into value-added products, such as mineral-enriched yogurt, without compromising its quality (Azorín et al., 2025). The relatively loose protein coagulation structure of goat milk, influenced by pH and protein stability, also supports faster gastric digestion and more efficient amino acid absorption than those of cow milk.

3. Alcohol Test

All milk samples yielded negative results in the alcohol test, indicating that no coagulation occurred when the milk was mixed with 70% alcohol. This finding confirms that milk proteins remained stable and that the milk had not undergone early spoilage.

Protein stability is an important indicator of milk quality and reflects the balance between acidity and mineral content. Negative results from the alcohol test generally indicate minimal

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microbial activity and appropriate handling practices during and after milking. In contrast, positive results are typically associated with increased acidity and protein destabilization caused by microbial fermentation.

A stable protein structure is essential for maintaining the nutritional value and processing quality of milk. Conventional thermal processing is widely used in dairy systems; however, emerging technologies, such as ultrasonic treatment, have been reported to enhance protein structure and improve milk stability (Chen et al., 2025). In addition, stable milk is more suitable for advanced storage techniques, including ultra-cryogenic freezing, which can help overcome seasonal production constraints while preserving milk quality (Yu et al., 2021).

Integrated Discussion

Overall, the results of the TPC, pH, and alcohol test analyses consistently indicated that the milk produced at the Padayo Goat Farm exhibited good microbiological and physicochemical quality. These parameters are interrelated; low microbial contamination contributes to a stable pH and prevents protein destabilization.

The findings highlight that proper hygiene practices, even within traditional smallholder systems, play a critical role in maintaining milk quality. This is particularly important in tropical environments, where high temperatures can accelerate microbial growth. Therefore, improving sanitation during milking and handling processes is essential to ensure the safety and quality of dairy products.

CONCLUSION

This study demonstrated that dairy goat milk produced at the Padayo Goat Farm complies with the Indonesian National Standard for both microbiological and physicochemical quality. The relatively low total plate count, normal pH range, and stable protein structure, as indicated by the negative alcohol test results, collectively confirm that the milk is safe, fresh, and suitable for further processing. These findings emphasize that smallholder dairy goat systems operating under tropical conditions are capable of producing high-quality milk, provided that proper hygiene practices and basic management standards are consistently applied. The integration of adequate milking sanitation, prompt postharvest handling, and controlled environmental exposure plays a crucial role in maintaining milk quality. From a broader perspective, this study highlights the potential of smallholder dairy farms to contribute to safe and sustainable milk production. Strengthening hygiene management and adopting simple technological improvements can further enhance product quality and market competitiveness. Therefore, smallholder-based dairy systems represent a viable pathway for supporting food safety, rural livelihoods, and sustainable livestock development in emerging economies. Future studies should incorporate larger sample sizes and additional quality parameters to further strengthen the scientific basis of smallholder dairy production systems.

REFERENCES

Ait El Alia, O., Chaji, S., Boukrouh, S., Kaddouri, M., Zine-Eddine, Y., & Boutoial, K. (2026). Recent advances in the authentication of goat milk and its derived products. *Journal of Food Composition and Analysis*, *152*, 109037. https://doi.org/10.1016/j.jfca.2026.109037

Azorín, I., Madrid, J., Martínez-Miró, S., López, M. B., López, M., & Hernández, F. (2025). Effects of dietary supplementation with selenium in organic form and iodine in dairy goats and their

transfer to milk and dairy products. *Veterinary and Animal Science*, *30*, 100520. https://doi.org/10.1016/j.vas.2025.100520

Badan Standardisasi Nasional. (2011). SNI 3141.1:2011 Fresh milk standard. Jakarta, Indonesia.

Chen, X., Wei, L., Mao, Y., Zhao, A., Pu, M., Liu, Y., & Wang, B. (2025). A comparative study of ultrasound and thermal processing: Effects on goat milk stability and protein structure. *Journal of Dairy Science*, *108*(4), 3273–3286. https://doi.org/10.1016/j.jds.2024.25918

Dwitania, D. C dan I. B. N. Swacita. 2013. Uji didih, alkohol dan derajat asam susu sapi kemasan yang dijual di pasar tradisional kota Denpasar. Laboratorium Kesehatan Masyarakat Veteriner. Fakultas Kedokteran Hewan, Universitas Udayana. Bali.

FAO and IDF. (2011). *Guide to good dairy farming practice*. Animal Production and Health Guidelines. No. 8. Rome.

Guo, S., Chen, M., Wu, T., Liu, K., Zhang, H., & Wang, J. (2022). Probiotic Bifidobacterium animalis ssp. lactis Probio-M8 improves the properties and organic acid metabolism of fermented goat milk. *Journal of Dairy Science*, *105*(12), 9426–9438. https://doi.org/10.3168/jds.2022-22003

Illikoud N., Carmo F. L. R., Daniel N., Jan G., Gagnaire V. (2023). Development of innovative fermented products by exploiting the diversity of immunomodulatory properties and fermentative activity of lactic and propionic acid bacteria. *Food Research International*, *166*, 112557. https://doi.org/10.1016/j.foodres.2023.112557

Nayik, G. A., Jagdale, Y. D., Gaikwad, S. A., Devkatte, A. N., Dar, A. H., & Ansari, M. J. (2022). Nutritional profile, processing and potential products: a comparative review of goat milk. *Dairy 3* (3), 622–647. https://doi.org/10.3390/dairy3030044

Obayomi, O. V., & Edo, G. I. (2025). Exploring the health benefits, mechanisms of action, and emerging safety concerns of fermented foods with emphasis on African foods. *Food Wellness*, *1*(1), 100021. https://doi.org/10.1016/j.foodw.2025.100021

Ratni, E., Lendrawati, & Arief. (2024a). The evolving landscape of milk consumption in Indonesia amidst the rise of contemporary beverages. *IOP Conference Series: Earth and Environmental Science*, *1341*, 012114. https://doi.org/10.1088/1755-1315/1341/1/012114

Ratni, E., & Lendrawati. (2024b). Consumption of pasteurized whole milk challenges in Padang, Indonesia: Insights from consumers and business perspectives. *Andalasian Livestock*, *1*(1), 70–77. https://doi.org/10.25077/alive.v1.n1.p70-77.2024

Ratni, E., Roza, E., & Arief. (2024c). Milk production, quality parameters, and bacterial colony counts of raw milk from Murrah buffaloes reared in mixed crop-livestock systems. *Journal of Buffalo Science, 13*, 24–30. https://doi.org/10.6000/1927-520X.2024.13.03

Ratni, E., Lendrawati, Islam, D., & Rachman, K. I. (2025). Temporal and spatial variations of temperature-humidity index related to heat stress in high-altitude dairy cattle farms. *Andalasian Livestock*, *2*(1), 98-106. https://doi.org/10.25077/alive.v2.n1.p98-106.2025

Sharma, H., & Ramanathan, R. (2023). Differences and correlation among various fatty acids of cow milk and goat milk probiotic yoghurt: Gas chromatography, PCA and network based analysis. *Food Chemistry Advances*, *3*, Article 100430. https://doi.org/10.1016/j.focha.2023.100430

 DOI: https://doi.org/10.25077/alive.v3.n1.p45-52.2026

Singh, S., Kaur, G., Brar, R. P. S., & Preet, G. S. (2021). Goat milk composition and nutritional value: A review. *The Pharma Innovation Journal, 10*(6), 536–540. https://www.thepharmajournal.com/archives/2021/vol10issue6S/PartH/S-10-6-55-130.pdf

Susanty, H., Ratni, E., & Sopiah, S. (2024). Subclinical mastitis prevalence of dairy goat smallholder farm and total plate count of the milk. *Andalasian Livestock*, *1*(1), 44-50. https://doi.org/10.25077/alive.v1.n1.p44-50.2024

Susanty, H., Arief, Hellyward, J., Ratni, E., Alzahra, W., Sopiah, S., & Ananda. (2025). Prevalence and microbial profiles of subclinical mastitis in dairy goats and their impact on milk quality in West Sumatra, Indonesia. *International Journal of Veterinary Science*, *14*(6), 1251–1256. https://doi.org/10.47278/journal.ijvs/2025.087

Thai Agricultural Standard. (2008). TAS 6006-2008. Raw goat milk. National Bureau of Agricultural Commodity and Food Standards, Ministry of Agriculture and Cooperatives. ICS 67.100.01. Royal Gazette. 125-139. Thailand.

van Eijnatten, E. J. M., Camps, G., Rombouts, W., Pellis, L., & Smeets, P. A. M. (2025). Gastric digestion and changes in serum amino acid concentrations after consumption of casein from cow and goat milk: A randomized crossover trial in healthy males. *The Journal of Nutrition*, *155*(10), 3374–3383. https://doi.org/10.1016/j.tjnut.2025.07.025

Yu, Z., Qiao, C., Zhang, X., Yan, L., Li, L., & Liu, Y. (2021). Screening of frozen-thawed conditions for keeping nutritive compositions and physicochemical characteristics of goat milk. *Journal of Dairy Science*, *104*(4), 4108–4118. https://doi.org/10.3168/jds.2020-19238

Zhang, X., Lv, J., Hui, J., Wu, A., Zhao, L., Feng, L., Deng, L., Yu, M., Liu, F., Yao, J., & Lei, X. (2024). Dietary saccharin sodium supplementation improves the production performance of dairy goats without residue in milk in summer. *Animal Nutrition*, *18*, 166–176. https://doi.org/10.1016/j.aninu.2024.04.018