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QUALITY OF ETAWA GOAT MILK (CAPRA AEGAGRUS HIRCUS) BASED ON PH TEST, REDUCTION TEST, AND TPC TEST AT RAKA ETAWA FARM, SINGAPADU KALER VILLAGE, SUKAWATI, GIANYAR

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Abstract

Milk is a nutritious animal-based food product and an essential source of calcium for the human body. This study aims to evaluate the quality of Peranakan Etawa (Capra aegagrus hircus) goat milk from Raka Etawa Farm, Singapadu Kaler Village, Sukawati Subdistrict, Gianyar Regency, based on pH test, reductase test, and Total Bacterial Plate Count (TPC) test. The research utilized 13 milk samples collected from lactating goats. The methodology involved measuring pH using a calibrated pH meter, performing a reductase test by observing the decolorization of methylene blue solution to assess microbial activity, and conducting the TPC test through serial dilution and nutrient agar cultivation techniques. The pH values of all samples ranged from 6.49 to 6.58, falling within the SNI 3141.1.2011 standard for fresh milk (6.3–6.8), indicating good freshness. The reductase test results showed a reduction time between 330–450 minutes (average 390 minutes), exceeding the minimum threshold of 2 hours and suggesting low microbial activity and good hygienic practices. However, the TPC test revealed an average bacterial count of 8.41 log cfu/mL, which surpassed the maximum allowable limit of 6.0 log cfu/mL, indicating microbial contamination. Pearson correlation analysis showed no significant relationship between pH, reductase time, and TPC ($p > 0.05$). In conclusion, although the milk meets freshness standards in terms of acidity and reductase time, it does not comply with microbiological standards due to high bacterial counts. Therefore, efforts to improve sanitation and milking hygiene are necessary. It is recommended that future research involve a larger sample size and multiple farm locations, and include additional quality tests to provide a more comprehensive analysis of goat milk quality.

Keywords: Milk, pH test, Reductase test, Total bacterial plate count (TPC).

INTRODUCTION

Goat milk is an animal-based food product produced by the mammary glands of mammals and extracted through milking (Hadiwiyoto, 1982). It contains important components such as proteins, fats, vitamins, minerals, lactose, enzymes, and beneficial microbes (Noor & Rachman, 2002). Due to its high digestibility and nutritional value, including calcium, phosphorus, vitamins A and B, goat milk has become a vital dietary source, especially for individuals needing recovery nutrition (Moeljanto & Wiryanta, 2002). Compared to cow milk, goat milk is more easily digested due to its smaller fat molecules, which are naturally

homogenized (Yudiawan, 2021). Among dairy goats in Indonesia, the Peranakan Etawa (PE) breed stands out due to its adaptability to local climates and low maintenance costs (Hijriah, 2016). PE goats are widely raised across the country and contribute significantly to household livelihoods, particularly in rural communities (Jahroh et al., 2020). One such example is Raka Etawa Farm in Singapadu Kaler Village, Gianyar Regency, Bali, which is the only dairy PE goat farm in the Sukawati subdistrict and plays an essential role in local milk supply.

The quality of milk is crucial to ensure public health and to prevent zoonotic disease transmission. Since milk is consumed directly by humans, particularly those with compromised immune systems, it is imperative to ensure its safety and freshness. According to Fadillah, Ramadhan, and Putri (2023), assessing milk quality is vital in preventing zoonosis and maintaining animal health. Quality assessment is generally categorized into subjective and objective tests. Subjective tests include evaluating color, odor, texture, and cleanliness, while objective tests involve measurable parameters such as pH level, reductase time, and Total Bacterial Plate Count (TBPC), also known as TPC. These objective tests are preferred due to their efficiency, affordability, and reliability in determining microbial contamination and freshness (Legowo et al., 2009; Zain, 2013; Sapei & Aziz, 2021).

Based on the relevance and necessity of quality control in dairy production, this study aims to assess the milk quality of Peranakan Etawa goats at Raka Etawa Farm based on pH testing, reductase test, and Total Bacterial Plate Count (TPC). Specifically, the research objectives are to (1) evaluate the pH values of PE goat milk; (2) determine the reductase time using methylene blue reduction; (3) analyze bacterial loads through TPC tests; and (4) identify correlations among pH, reductase, and TPC values as indicators of milk quality.

MATERIALS AND METHODS

Ethical Approval for Animal Subjects

Ethical approval is not required, as this study did not involve animal experimentation or invasive procedures. Milk samples were collected through manual milking from lactating goats during routine farm practices, with no interventions affecting animal welfare.

Research Subjects

The subjects in this study were 13 lactating Peranakan Etawa goats from Raka Etawa Farm, located in Singapadu Kaler Village, Sukawati Subdistrict, Gianyar Regency, Bali. Milk samples were obtained from each goat using hand milking techniques under hygienic conditions. A total of 30 mL of milk was collected per animal and stored in sterile 100 mL bottles inside a cool box containing ice packs to maintain freshness until laboratory analysis. The sampling followed purposive sampling criteria, focusing on goats actively in their lactation period to ensure consistency in milk production and composition.

Research Methods

Data collection included three types of milk quality tests:

pH Test

The pH value of each milk sample was measured using a digital pH meter that had been calibrated at pH 4.0 and pH 7.0. A volume of 20 mL of fresh milk was placed in a clean beaker glass, and the electrode was immersed to obtain the pH reading. Measurements were repeated for each of the 13 samples to ensure accuracy and consistency.

Reductase Test

A reductase test was performed to estimate the microbial activity in the milk. A solution of methylene blue (0.005%) was prepared, and 1 mL of this solution was mixed with 5 mL of milk in a test tube. The tube was sealed with cotton and incubated at 37°C. The time taken for the blue color to disappear was recorded as the reductase time. Milk was considered of good quality if the decolorization occurred in ≥2 hours.

Total Plate Count (TPC) Test

The total bacterial count was assessed using the standard plate count method. Milk samples were serially diluted (10^{-1} to 10^{-5}) using sterile distilled water. One milliliter from each dilution was plated on nutrient agar and incubated at 37°C for 18–24 hours. Colony-forming units (cfu) were counted, and results were expressed as log cfu/mL.

Data Analysis

The data were tabulated and analyzed using descriptive statistics to summarize the findings from each test. The TPC results were transformed into logarithmic form ($\log_{10}$ cfu/mL) for normalization before analysis. Pearson correlation analysis was conducted using IBM SPSS Statistics version 27 to assess the relationship between the three parameters: pH value, reductase time, and total bacterial count (TPC). A significance level of $p < 0.05$ was used to determine statistical relevance. The results were presented in tables with means, standard deviations, and correlation values.

RESULTS AND DISCUSSION

Results

The results of this study include pH test, reductase test, and total bacterial plate count (TPC) from 13 Peranakan Etawa goat milk samples taken from Raka Etawa Farm.

pH Test

The pH test results are shown in Table 1.

Table 1. pH Values of Peranakan Etawa Goat Milk Samples from Raka Etawa Farm.

Sample code	Repeat pH value		Average	Standard Deviation
	I	II		
SS 1	6.51	6.52	6.52	0.007
SS 2	6.50	6.61	6.56	0.078
SS 3	6.54	6.56	6.55	0.014
SS 4	6.57	6.56	6.57	0.007
SS 5	6.51	6.53	6.52	0.007
SS 6	6.49	6.54	6.49	0.035
SS 7	6.55	6.55	6.55	0.000
SS 8	6.51	6.50	6.51	0.007
SS 9	6.53	6.51	6.52	0.014
SS 10	6.58	6.57	6.58	0.007
SS 11	6.55	6.60	6.55	0.035
SS 12	6.57	6.52	6.55	0.035
SS 13	6.56	6.53	6.55	0.021
Average	6.5400	6.5754	6.54	0.0173
Standard Deviation	0.02582	0.18804	0.19526	0.0958

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The pH test results of 13 Peranakan Etawa goat milk samples collected from Raka Etawa Farm showed values ranging from 6.49 to 6.58, with an average pH of 6.54. These values fall within the standard range set by SNI 3141.1.2011 for fresh milk, which is 6.3–6.8. This indicates that the milk was still in a fresh state and had not undergone significant microbial fermentation that would cause a drop in pH.The low standard deviation indicates that sample handling and measurement were consistent. These findings are consistent with Rosartio et al (2015) and Zain (2013), who also reported that fresh goat milk typically maintains a pH value around 6.5.

Reductase Test

The reductase test evaluates the microbial activity in milk through the decolorization time of methylene blue solution. All 13 samples showed reduction times ranging from 330 to 450 minutes, with an average of 390 minutes (6.5 hours), which exceeds the minimum requirement of 2 hours according to the Directorate General of Livestock regulation.

Table 2. Reductase Times of Peranakan Etawa Goat Milk Samples

Sample code	Repeat Reductase Value		Average	Standard Deviation
	I	II		
SS 1	330	450	390	78.10
SS 2	330	450	390	78.10
SS 3	330	450	390	78.10
SS 4	330	450	390	78.10
SS 5	330	450	390	78.10
SS 6	330	450	390	78.10
SS 7	330	450	390	78.10
SS 8	330	450	390	78.10
SS 9	330	450	390	78.10
SS 10	330	450	390	78.10
SS 11	330	450	390	78.10
SS 12	330	450	390	78.10
SS 13	330	450	390	78.10
Average	330	450	390	78.10
Standard Deviation	0.000	0.000	0.000	0.000

The long reductase times indicate that microbial counts were low, and milk quality was still good. These results are in line with Legowo et al (2009), who suggested that good quality milk has reductase times of 300–420 minutes. Consistent values across samples also reflect good hygiene during the milking process.

Total Plate Count (TPC) Test

The TPCtest showed that total bacterial counts in the samples ranged from 2.18 to 16.37 log cfu/mL, with an average of 8.41 log cfu/mL. According to SNI 3141.1.2011, the maximum permissible limit for total bacteria in fresh milk is 6.0 log cfu/mL. Therefore, most samples in this study exceeded the acceptable limit.

Despite the good results from the pH and reductase tests, the high bacterial counts suggest contamination possibly occurred during or after milking, such as from equipment, environment, or storage issues. These findings agree with Fadillah et al (2023), who noted that proper sanitation is crucial to maintaining microbiological milk quality.

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Table 3. Total bacterial plate count (TPC) values of Goat Milk Samples (log cfu/mL)

Sample Code	Colony Count
SS 1	36×10^1
SS 2	27×10^1
SS 3	184×10^1
SS 4	19×10^1
SS 5	180×10^1
SS 6	140×10^1
SS 7	28×10^1
SS 8	36×10^1
SS 9	105×10^1
SS 10	107×10^1
SS 11	19×10^1
SS 12	3×10^1
SS 13	15×10^1
Average	7.07×10^1
Standard Deviation	6.40×10^1

Correlation Between pH Test, Reductase Test, and Total bacterial plate count (TPC) Test

Pearson correlation analysis showed no significant correlation between pH, reductase time, and TPC ($p > 0.05$), indicating that these parameters function independently in assessing milk quality.

Table 4. Pearson Correlation Between pH Test, Reductase Test, and Total bacterial plate count (TPC) Test

Variable	pH Test	Reductase Test	Test TPC
UJI_pH	1	0.141	0.095
Sig. (2-tailed)	-	0.645	0.757
N	13	13	13
TEST_REDUCTION	0.141	1	0.210
Sig. (2-tailed)	0.645	-	0.492
N	13	13	13
TEST_TPC	0.095	0.210	1
Sig. (2-tailed)	0.757	0.492	-
N	13	13	13

This suggests that while pH and reductase can indicate milk freshness, they do not predict bacterial load. Thus, all three tests are necessary to provide a comprehensive quality assessment.

Discussion

The results of this study indicate that the milk produced by Peranakan Etawa goats at Raka Etawa Farm is chemically fresh but microbiologically contaminated. The pH values ranging from 6.49 to 6.58 confirm that the milk falls within the acceptable standard of fresh milk, as outlined by SNI 3141.1.2011. These results are in line with the findings of Rosartio et al (2015) and Zain (2013), who reported that fresh goat milk typically has a pH of 6.5 to 6.7. Proper milking hygiene, udder health, and immediate storage contribute to stable milk acidity (Yudiawan, 2021).

The reductase test, which functions as an indirect measurement of microbial activity, showed a uniform reduction time across all samples ranging from 330 to 450 minutes, with an average of 390 minutes. According to Partic (2010), a longer decolorization time of methylene blue correlates with lower bacterial loads, indicating that the milk is still fresh and suitable for consumption. These results are consistent with previous findings by Novita et al (2022) and Legowo et al (2009), which also reported long reductase times in goat milk under hygienic milking conditions. This suggests that the sanitary milking and cooling protocols applied at Raka Etawa Farm were effectively inhibiting early microbial growth.

However, a major inconsistency emerged in the TPC results, where the average bacterial count was 8.41 log cfu/mL significantly above the maximum permissible limit of 6.0 log cfu/mL set by the Indonesian National Standard. This finding indicates a high level of bacterial contamination despite good chemical indicators of milk freshness. Similar trends were reported by Fadillah et al (2023), who found that poor sanitation, improper handling of equipment, and delayed refrigeration are major causes of increased microbial counts. Sundari and Fadhliani (2019) also emphasized that environmental hygiene during milking is a critical factor in determining microbiological quality.

The Pearson correlation test revealed no significant relationship between pH, reductase time, and TPC ($p > 0.05$), indicating that each parameter measures a different aspect of milk quality. According to Jay et al (2005), pH reflects chemical stability, the reductase test assesses microbial respiration activity, and TPC directly measures viable bacterial populations. Therefore, a holistic evaluation of milk safety must include all three parameters to avoid misleading conclusions.

These findings highlight a potential gap between on-farm practices and post-milking handling. Although milking appears hygienic based on pH and reductase results, microbial contamination might still occur due to unsterilized equipment, handlers' hygiene, or insufficient cooling during storage and transportation (Sapei & Aziz, 2021). Strengthening hygiene protocols and implementing stricter post-harvest milk handling are essential steps toward improving microbiological safety.

CONCLUSIONS AND SUGGESTIONS

Conclusions

Based on the results of the study, it can be concluded that the milk produced by Peranakan Etawa goats at Raka Etawa Farm meets the standards for fresh milk in terms of pH and reductase time. The average pH value of 6.54 and reductase time of 390 minutes indicate that the milk is chemically fresh and has low microbial activity. However, the microbiological quality, as measured by the Total Plate Count (TPC), did not meet the national standard, with an average bacterial count of 8.41 log cfu/mL, exceeding the SNI limit of 6.0 log cfu/mL. This indicates possible contamination during the post-milking process. Furthermore, the correlation test showed no significant relationship between pH, reductase time, and TPC, indicating that each test measures different aspects of milk quality.

Suggestions

To improve the microbiological quality of goat milk, it is recommended that Raka Etawa Farm enhance sanitation procedures, especially in equipment sterilization, milking hygiene, and milk storage. Future studies should involve more samples from various farms and include additional quality parameters such as alcohol test, specific gravity, and somatic cell count for a more comprehensive evaluation.

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