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Research Article

Evaluation of Protein, Lactose Content, Boiling Test, Total Solids, and Solid Non-Fat in PFH Cow's Milk at Moosa Edufarm, West Sumatra

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ABSTRACT

This study aimed to evaluate the quality of milk produced by Peranakan Friesian Holstein (PFH) cows at Moosa Edufarm, Solok Regency, West Sumatra. Six fresh milk samples from cows at different lactation stages were analyzed for the boiling test (protein stability), total solids (TS), solid nonfat (SNF), protein content, and lactose content. TS and SNF were measured using the gravimetric method, while protein and lactose were analyzed using a Lactoscan device. The results indicated that all milk samples were negative for coagulation in the boiling test, indicating casein stability and freshness. The average TS content was 18.95 ± 4.37% and SNF was 14.45 ± 3.76%, both exceeding the minimum standards set by the Indonesian National Standard (SNI 3141.1-2011). The average protein content was 2.84 ± 0.14%, with the SNI minimum standard of 2.8%. The average lactose content was 4.25 ± 0.21%, within the normal range according to the literature. Variation in results among samples was influenced by feeding regime, lactation stage, cow health, age and post-milking handling. Overall, the milk produced met national quality standards and was suitable for direct consumption and processing into dairy products.

Keywords: lactose, milk quality, PFH cow, total solid, SNI

INTRODUCTION

Cows' milk is one of the livestock products with high nutritional value, containing proteins, fats, carbohydrates, vitamins, and minerals that are essential for human health. This high nutritional content makes milk a strategic food commodity that requires strict quality control. The Indonesian National Standard (SNI 3141.1:2011) sets quality parameters for fresh milk, including a minimum protein content of 2.8%, a minimum total solid of 10.81%, and a minimum solid non-fat (SNF) of 7.8%. Hasanah (2021) reported that PFH cow's milk fed with A18 concentrate and silage contained 12.63% total solids (TS) and 7.88% Total Solid Non-fat (TNS). According to Okta et.al. (2017), dairy cow's milk has a composition of 87.20% water, 3.70% fat, 3.50% protein, 4.90% lactose, and 0.07% minerals. Factors influencing milk quality include feed, lactation stage, cow health, and post-milking handling.

Moosa Edufarm, located in Gunung Talang, Solok Regency, has an environment highly supportive of dairy farming, both in terms of climate and forage availability. This study aimed to measure and analyze the quality of PFH cow milk at Moosa Edufarm with a focus on physical and chemical parameters and to compare the results with the Indonesian National Standards (SNI) standards.

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MATERIAL AND METHODS

Research Location and Time

This study was conducted in July 2025 at Moosa Edufarm, Solok Regency, and laboratory analyses were performed at LLDIKTI and the Dairy Production Laboratory, Universitas Andalas. Samples were collected from six lactating PFH cows at different lactation stages.

Materials and Tools

Materials: We used 250 mL of PFH cow's milk from six cows at different lactation ages (I, II, III, IV, V, and VI). The population of cows and criteria of cows are described in Tables 1 and 2. Tools: We used test tubes, clamps, a Bunsen burner, Lactoscan, beaker glass, ceramic dish, desiccator, clamps, oven, digital balance, plastic containers, and a cooling box.

Table 1. PFH Cattle Population at Moosa Edufarm

No.	Type	Heads
1.	Calves	4
2.	Heifers	1
3.	Lactating	6
4.	Dry Cows	1
5.	Non-milking	1
	Total	13

Table 2. PFH Cow's by Age, Production, and Lactation Stage

Cow's ID	Age (Years)	Lactation Stage
22	7.50	VI
20	7.00	V
32	6.50	IV
39	4.90	III
43	4.90	II
87	2.70	I

Research Method

This study used a descriptive qualitative method. The data consisted of primary and secondary sources. Primary data were obtained from boiling tests, protein content, lactose content, total solids, and SNF. Secondary data were collected through interviews with farmers in the field, records of milk production at Moosa Edufarm and related institutions, and laboratory results from LLDIKTI and Universitas Andalas. The data were analyzed descriptively by calculating the mean and standard deviation for each parameter.

Research Parameters

a. Boiling Test (method Siwoloboff)

The principle of the boiling test is to evaluate milk stability upon heating to boiling. Poor-quality milk curdles or coagulates because of reduced acidity, which destabilizes casein and triggers coagulation. Conversely, good-quality milk remains homogeneous without separation or clumping. Procedure: Milk (5 mL) was placed in a test tube, heated until boiling, cooled, and observed. Homogeneity indicated a negative result, whereas curdling indicated a positive result.

b. Protein and Lactose Content (AOAC)

Measured using a Lactoscan based on infrared principles. Homogenized milk samples (50 mL) at room temperature were placed in the Lactoscan for automatic analysis, and the results were displayed on the screen.

c. Total Solids and Solid Non-Fat (SNF)

Measured using the gravimetric method. Clean empty dishes were oven-dried at 103 ± 2 °C for 60 min, cooled in a desiccator, and weighed (X0). Milk samples (~5 g) were weighed into the dishes (X1), oven-dried for 4 h, cooled, and reweighed (X2).

a. Total Solid :

$$\%Total\ Solid = \frac{X2 - X0}{X1 - X0} x100$$

b. Solid Non Fat (SNF)

$$\%SNF = TS - L$$

Where:

X0 = Weight of empty dish

X1 = Weight of dish + sample before oven

X2 = Weight of dish + sample after oven

TS = Total Solids (%)

SNF = Solid Non-Fat (%)

L = Fat Content (%)

RESULTS AND DISCUSSION

All data are shown in Table 3.

Table 3. Results of Boiling Test Evaluation and Protein Content, Lactose Content, Total Solids (TS), and Solid Non-Fat (SNF) of Fresh PFH Cow's Milk at Moosa Edufarm

No.	Cow's ID	Milk Production (L/day)	Boiling Test	Total Solid (%)	Solid Non-Fat (%)	Protein (%)	Lactose (%)
1.	22	10.78	Negatif	14.49	10.80	2.84	4.27
2.	20	8.48	Negatif	17.58	13.06	2.64	3.94
3.	32	6.36	Negatif	14.39	9.38	2.89	4.33
4.	39	15.49	Negatif	22.74	17.92	2.87	4.29
5.	43	5.89	Negatif	25.16	18.64	3.06	4.57
6.	87	9.29	Negatif	19.31	14.87	2.75	4.12
Minimal value of Standard (SNI 3141.1-2011)				10.81	7.8	2.80	-

Boiling Test

All milk samples from Moosa Edufarm showed negative results, indicating that no coagulation occurred when boiled. Milk boiled at 100.2–100.5°C, slightly higher than pure water due to dissolved components (lactose, proteins, and minerals). This difference is small but relevant in milk processing and quality control.

Positive results in boiling tests are usually caused by factors such as milk instability during milking, the presence of colostrum, dry cow conditions, or mastitis infection (Sousa et al., 2012). External factors, such as microbial contamination during production, storage, or transport, can

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also trigger coagulation (Sanders, 2012). Such coagulation indicates reduced quality and potential for increased acidity, making the milk unfit for consumption (Struijk et al., 2001).

Protein Content

As shown in Table 3, the average protein content of milk was 2.84 ± 0.14%. However, two samples (S20 and S87) did not meet the minimum standard. This may indicate a decline in milk quality caused by various technical and biological factors. To meet national quality standards, feed management, cow health, and husbandry practices should be comprehensively evaluated.

Cow 43 (age 4.9 years, 5.89 L/day, 2nd lactation) had the highest protein content (3.06%), consistent with the characteristic of low-producing cows yielding more concentrated milk. This high protein level may also be due to a balanced feed supporting milk protein synthesis. Cow 32 (age 6.5 years, 6.36 L/day, 4th lactation) had a protein level of 2.89%, above the SNI standard, which is in accordance with its lower production. Cow 39 (age 4.9 years, 15.49 L/day, 3rd lactation) had 2.87%, proving that high milk volume does not necessarily reduce protein content if the feed is sufficient. Cow 22 (age 7.5 years, 10.78 L/day, 6th lactation) had 2.84%, just above the minimum SNI threshold, which is reasonable for older cows in late lactation when protein metabolism declines.

Two cows failed to meet the 2.8% minimum: Cow 20 (2.64%; age, 7 years; 8.48 L/day; 5th lactation) and Cow 87 (2.75%; age, 2.7 years; 9.29 L/day; 1st lactation). In Cow 20, the decrease may be due to declining metabolic efficiency in older cows. For Cow 87, nutrients may have been prioritized for body growth as well as milk production, slightly limiting milk protein synthesis.

In early lactation, the protein content of cow milk is generally higher than that of fat because the first secretion is colostrum, which is yellowish, viscous, and rich in protein. Protein levels gradually decrease as fat levels increase (Nugraha et al., 2016). According to Walstra et al. (2006), the normal protein content of fresh cow milk ranges from 2.8% to 3.4%. Protein measurement is used to evaluate the stability and quality of milk products.

The results of this study showed that the protein content of PFH cow's milk (2.84%) was lower than that reported by Oka et al. (2017). This difference may be attributed to variations in the protein and fat content of the feed and the health conditions of the livestock, factors that can affect milk protein content. With two samples below the SNI, low protein levels could be due to protein-deficient feed or suboptimal cow health.

Lactose Content

As shown in Table 3, Cow 43 (age 4.9 years, 5.89 L/day, 2nd lactation) had the highest lactose (4.57%), reflecting efficient carbohydrate metabolism despite low milk yield. Cow 32 (age 6.5 years, 6.36 L/day, 4th lactation) had 4.33%, which is also high and indicates good udder health. Cow 39 (age 4.9 years, 15.49 L/day, 3rd lactation) had 4.29%, showing that high production can still maintain normal lactose if supported by good feed. Cow 22 (age 7.5 years, 10.78 L/day, 6th lactation) recorded 4.27%, which was stable for an older cow. Cow 87 (age 2.7 years, 9.29 L/day, 1st lactation) had 4.12%, which was still within the normal range, showing healthy udder function despite ongoing body growth. Cow 20 (age 7 years, 8.48 L/day, 5th lactation) had the lowest value (3.94%), likely due to late lactation when lactose synthesis typically declines.

Overall, the lactose content ranged from 3.94% to 4.57%, with an average of 4.25%, which falls within the normal range of 4.2%–5.0% reported by Fox and McSweeney (2015). Lactose stability indicates good milk production, handling, and storage without microbial fermentation.

The lactose content of this study (3.94–4.57 %) was lower than that (4.90%) reported by Oka et al. (2017). Lactose content is influenced by the nutritional content of the feed. Lactose levels are influenced by the lactation stage, udder health, and feed quality. Moreover, lactose plays an important role in fermented dairy products and can serve as an early indicator of microbial spoilage (Nugroho, 2018; Iswanto, 2021).

Total Solids and Solid Non-Fat (SNF)

The total solids (TS) content ranged from 14.36% to 25.16% (average 18.95 ± 4.37%), while SNF ranged from 9.38% to 18.64% (average 14.45 ± 3.76%). These values exceeded the minimum SNI standards, indicating good nutrient content. Cow 43 (4.9 years, 5.89 L/day, 2nd lactation) had the highest TS (25.163%) and SNF (18.643%). Its low yield resulted in more concentrated solids due to lower water secretion. Cow 39 (4.9 years, 15.49 L/day, 3rd lactation) also showed high TS (22.742%) and SNF (17.922%) despite its highest production volume, reflecting balanced feed and good udder health. Cow 87 (2.7 years, 9.29 L/day, 1st lactation) recorded TS 19.314% and SNF 14.874%, relatively high for a young first-lactation cow, suggesting good genetic potential. Cow 20 (7 years, 8.48 L/day, 5th lactation) had TS 17.584% and SNF 13.064%, meeting SNI but lower than that of its peers, possibly due to age-related metabolic decline.

Meanwhile, TS and SNF were lowest in Cow 22 (7.5 years, 10.78 L/day, 6th lactation; 14.491% and 10.801 %) and Cow 32 (6.5 years, 6.36 L/day, 4th lactation; 14.359% and 9.385%, respectively). Relatively high production at an older age in Cow 22 may dilute nutrient concentration, whereas low production with equally low solids in Cow 32 may reflect feed or health limitations. Variations in TS and SNF across samples may be caused by differences in feed quality, lactation stage, and cow health (Marwah et al., 2010).

Recommendation

To ensure consistent quality and further improve the nutritional composition of milk, Moosa Edufarm is advised to implement more standardized feed management, adjust rations according to the stage of lactation, and conduct routine health monitoring of the cows. Particular attention should be given to cases of reduced protein content, such as in Cows 20 and 87, by evaluating feed nutrition, applying proper lactation management, and performing regular udder health checks. Although the test results demonstrate that the milk quality is good, strict adherence to hygiene practices during milking and post-milking handling must be maintained and continuously improved to prevent microbial contamination. In addition, regular monitoring of chemical and physical parameters, such as protein, fat, lactose, and total solids, should be conducted to ensure that the milk consistently meets SNI standards.

CONCLUSION

The results of this study indicate that PFH cow's milk produced at Moosa Edufarm meets the requirements of SNI-3141.1-2011. All samples showed negative results in the boiling test, with total solids (18.95 ± 4.37%), solid non-fat (14.45 ± 3.76%), protein (2.84 ± 0.14%), and lactose (4.25 ± 0.21%) values falling within the normal range. Although there were two samples with protein content below the minimum SNI standard. The variations observed among individual samples were influenced by several factors, including feed quality, lactation stage, age, production level, cow health, and post-milking handling. Overall, the milk produced at Moosa Edufarm is of good quality and suitable for both direct consumption and further processing.

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