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The Effectivity of Giving Citronella Ark Blok to Improve the Quality of Etawah Crossbreed Goat Milk

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ABSTRACT. This study aimed to evaluate the effect of citronella ark blocks on the fat, lactose, and protein content of Etawah crossbreed goat milk. The study used five female Etawah crossbreed goats, each in their first and fifth lactation periods. A Latin Square Design (LSD) was employed, with five treatments and five replications, as follows: P0: 0% citronella block, P1: 2% of total ration, P2: 4% of total ration, P3: 6% of total ration, and P4: 8% of total ration. The parameters measured included milk fat, lactose, and protein content. The results indicated that the administration of citronella ark blocks had no significant effect ($P>0.05$) on the milk quality of Etawah crossbreed goats. Before treatment, the milk had an average fat content of 4.16%, lactose content of 3.91%, and protein content of 4.11%. After treatment, the milk quality improved, with fat content reaching 4.9%, lactose content 4%, and protein content 4.16%. Therefore, the use of citronella ark blocks may enhance milk quality, offering significant benefits for the dairy goat farming industry.

Keywords: block citronella, etawa crossbreed goat, fat content, lactose content, protein content

INTRODUCTION

According to data from the Central Statistics Agency, the Indonesian population's milk consumption reached 4.5 million tons per year in 2019. The growing public awareness of the nutritional benefits of fresh milk has led to an increase in milk demand. However, this demand remains unmet, as fresh milk production in Indonesia was only 947,685 tons in 2020, according to the Directorate General of Livestock and Animal Health. Indonesia's milk production currently fulfills only 20-40% of the domestic demand. This shortfall is primarily due to low average dairy production, which is affected by factors such as poor-quality feed, substandard seed quality, limited capital, and suboptimal management practices (Ginting, 2023). Goat milk, particularly from the Etawah crossbreed, is a vital product that could contribute significantly to meeting Indonesia's milk demand. However, many farmers face challenges with milk quality not meeting processing standards, leading to rejections by cooperatives and financial losses.

Milk quality is primarily influenced by the nutritional content of the feed. Poor-quality feed reduces nutrient absorption, directly affecting the milk's composition. To address this issue, the use of feed additives can enhance productivity and ensure that milk meets the necessary quality standards. Common feed additives include antibiotics, probiotics, prebiotics, enzymes, and plant bioactives (Golowczyc and Gomez-Zavaglia, 2024).

Citronella waste, an agricultural byproduct, offers a potential solution as animal feed. Compared to rice straw, citronella waste has superior quality, with a protein content of 7%, significantly higher than the 3.9% found in rice straw. Moreover, citronella waste has a lower crude fiber content (25.7%) compared to both rice straw and elephant grass (Novita et al., 2020). However, citronella waste's high lignin content makes it challenging for livestock to digest. To improve digestibility, ammoniation was applied to citronella waste. This process breaks down lignin bonds, making the feed materials softer and more digestible, thereby improving feed consumption, digestible energy, and organic matter content (A'la et al., 2020).

Ark is a feed additive made from tape-cucuma paste and sakura block. Tape is a source of easily digestible carbohydrates and contains Saccharomyces cerevisiae, which helps maintain the balance of rumen microbes, increasing nutrient intake and digestibility. Administering ark blocks exceeding 450g to cattle has been shown to increase milk production from 7.04 kg/head/day to 9.38 kg/head/day, a 24.89% increase (Sulistyowati and Edward, 2009). Other studies have reported that administering 900g of ark increased the protein content in milk (Jarmuji et al., 2021).

The combination of citronella waste with ark in citronella ark blocks may also improve the lactose content in milk. Curcuminoids and essential oils in ark enhance digestive efficiency, especially in the small intestine, by improving the absorption of easily digestible carbohydrates such as those

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found in tape. These carbohydrates are fermented in the rumen into propionic acid, which is then converted into glucose in the liver. Glucose is transported to the udder gland, where it is used to synthesize lactose in milk (Dzarnisa and Ramaya, 2022). These bioactives also exhibit anti-inflammatory and anti-parasitic properties (Cheraghipour et al., 2018).

This study investigates the effects of citronella ark blocks on the milk quality of Etawah goats. We hypothesize that adding citronella waste will improve milk protein production, as higher crude protein intake typically leads to higher milk yield. Given that Etawah crossbreed goats are known for their elevated lactose and protein levels, we aim to identify the optimal concentration of citronella ark blocks that improves milk quality and enhances market value.

MATERIALS AND METHODS

Place and Time of Research

This study was conducted at the Kutaraja Aqiqah Dairy Goat Farm, located in Rumpet, Aceh Besar. The milk analysis was carried out at the Laboratory of Ruminant Science and Technology, within the Dairy Farming section of the Animal Husbandry Study Program at the Faculty of Agriculture, Universitas Syiah Kuala. The citronella ark blocks were produced at the Animal Husbandry Field Laboratory, also part of the Animal Husbandry Study Program at the Faculty of Agriculture, Syiah Kuala University. The drying of citronella ark blocks was done using the Hohenheim drying method at Meugah Plik UKM in Cot Cut, Aceh Besar. The research was conducted from July to December 2021.

Research Materials

The study involved five female Etawah crossbreed goats in their first through fifth lactation periods, sourced from the Kutaraja Aqiqah Dairy Goat Farm in Rumpet, Aceh Besar. The materials used in the study included citronella blocks and various ingredients such as tape, corn, bran, lime, NaCl, TSP, cement, premix, urea, and fine curcuma. These materials were obtained from local vendors in Banda Aceh, while citronella waste was sourced from Saree, Aceh Besar.

Research Tools and Materials

The tools and equipment used in this study included plastic buckets, digital scales, Lactoscan Farm Eco equipment, glass beakers, blenders, molds, Hohenheim drying units, sample bottles, washcloths or tissues, masks, gloves, cooler boxes, stationery, and mobile phones. The ingredients for the preparation of the ark blocks included fresh milk, block citronella extract, water, equates, and Lactodaily solution.

Research Procedure

This study was conducted in two phases: the preparation phase and the implementation phase.

Preparation Phase

The preparation phase lasted one week and involved cleaning the cages, selecting the goats based on their lactation periods (from the first to fifth lactation), and randomly assigning the goats to numbered cages for identification. The feed mixture (ark) was prepared with the following ingredients: 28% cassava tape, 15% fine corn, 15% bran, 3% lime, 3% salt, 1% TSP, 3.5% cement, 1.5% premix, 3% urea, 25% curcuma solution, and 2% citronella. This formulation was designed to provide the necessary nutrition for the goats' healthy growth. The curcuma solution was prepared in a 2:1 weight/volume (w/v) ratio, where curcuma served as the solute and water as the solvent. All ingredients were thoroughly mixed, weighed according to the ark block treatment levels, molded into round shapes, and then dried using the Hohenheim drying method for five days until they hardened.

Implementation Phase

Following the preparation phase, a one-week adaptation period was conducted to allow the goats to adjust to the experimental conditions before the treatment began. During the adaptation phase, the impact of the feed on the experimental parameters was minimized. The adaptation period was followed by two weeks of data collection, divided into five repeated intervals.

The experimental cages, each measuring 1x3 meters, were modified for the study. During the treatment period, goats were provided with both forage and concentrate feeds. The feeding plan was designed according to specific nutritional requirements: 3% dry matter for concentrate and 10% fresh matter based on the body weight of the goats for forage feed. The concentrate was administered once daily at 07:00 WIB, while the forage was provided twice a day at 09:00 WIB and 17:00 WIB. The citronella ark blocks were administered alongside the concentrate feed, in a dry form. The treatments applied in this study included: P0= 0% citronella ark block, P1= 2% of the total ration, P2= 4% of the total ration, P3= 6% of the total ration, and P4= 8% of the total ration.

Milk quality data were collected by measuring fat, lactose, and protein content during 15 sampling sessions, conducted every Tuesday over a three-month period. Milking took place at 06:00 WIB, with the udder prepped by wiping it with a warm, moistened cloth to ensure cleanliness. Manual milking was performed using the "whole tip" technique, with the collected milk stored in clean containers. After milking, the milk was immediately bottled, placed in a cooler box, and transported to the Laboratory of Ruminant Science and Technology for quality testing.

Table 1. Table of feeding plan

As Feed Composition	Treatment				
	P0	P1	P2	P3	P4
Elephant grass	2819.25	2819.25	2819.25	2819.25	2819.25
Dwarf Elephant Grass	542.99	542.99	542.99	542.99	542.99
Tofu Dregs	3287.67	3123.29	2958.90	2794.52	2630.14
Citronella Ark Block	0.00	28.00	56.00	84.00	112.00
Total (g)	6649.91	6513.53	6377.14	6240.76	6104.38

Note: P0= 0% citronella ark block, P1= 2% of the total ration, P2= 4% of the total ration, P3= 6% of the total ration, and P4= 8% of the total ration

To analyze the milk quality (specifically fat, lactose, and protein content), the Lactoscan Farm Eco device was used following the standard procedure outlined below; Turn on the Lactoscan Farm Eco machine and plug it in. Warm Up: Wait for the machine to complete its warm-up process. Milk Preparation: Pour approximately 20 ml of milk into a clean glass beaker. Machine Setup: Press and hold the "Enter" button to begin the analysis. Species Selection: Select the "Sheep" option and press "Enter". Analysis: The machine will analyze the sample, and the results (fat, lactose, and protein content) will be printed out. This standardized process ensures accurate and reliable milk testing, facilitating consistent data collection throughout the study

Research Design

The study utilizes a Latin Square Design (RBSL), which includes five treatments and five periods (or repeats) Using formula:

$$Yijk = \mu + \alpha i + ßj + \tau(k) + \Sigma ij(k)$$

Which:

Yijk = The response variable for the k-th observation in the i-th level of factor A and the j-th level of factor B

μ = The overall mean of the response variable.

αi = The represents the effect of the i-th level of factor A.

ßj = This represents the effect of the j-th level of factor B

τ(k) = This represents the effect of the j-th level of factor B

Σij(k) = The error term (or residual)

Statistical Analysis

The collected data will be analyzed using Analysis of Variance (ANOVA) to determine the presence of significant differences between the treatment groups. If significant differences are identified, post-hoc analysis will be performed using the Duncan Multiple Range Test, as outlined by Steel and Torrie (1991), to further assess the pairwise differences between treatments.

RESULTS AND DISCUSSION

Quality of Etawa Crossbreed Goat Milk

One of the key factors influencing milk quality is the composition of the feed provided to the goats. Nutritionally balanced and easily digestible feed is crucial for enhancing milk quality, as the nutrients absorbed from the feed are metabolized in the bloodstream and subsequently used to synthesize milk. The nutrient profile of the milk, including its levels of lactose, fat, protein, vitamins, and minerals, significantly contributes to its overall quality. The average quality of Etawa crossbreed goat milk prior to the commencement of the study is summarized in Table 2. These baseline data are essential for understanding the impact of the different treatments on the milk's nutritional content throughout the research period.

Based on the results of the analysis, the lactose content in the milk of Etawa goats prior to receiving the treatment feed was found to be lower at 3.91%. This finding contrasts with the results reported by Adriani et al. (2002), who observed a higher lactose level of 4.5%. Additionally, the analysis of fat and protein levels, as shown in Table 2, reveals that the milk quality meets the criteria for premium quality, as outlined by the Thai Agricultural Standard (2008) No. 60062008.

Fat Content of Etawa Crossbreed Goat Milk

The analysis of milk fat content revealed no significant effect (P>0.05). The average milk fat content ranged from 4.42% to 4.9%. Goats fed with treated feed showed higher fat content (4.9%) compared to those not receiving treated feed (4.1%). As shown in Table 3, the 8% citronella block treatment (P4) resulted in the highest milk fat levels. The increase in fat content in Etawa crossbreed goats fed with citronella blocks can be attributed to the citronella's acetic acid content, which plays a crucial role in the formation of fatty acids (Hernández et al., 2019).

Table 2. Results of analysis of the quality of milk of etawa crossbreed goats before research

Parameters	Treatment					Average
	P0	P1	P2	P3	P4	
Fat Content (%)	3.64	4.34	3.35	4.68	4.80	4.16
Lactose Content (%)	3.78	3.72	3.93	4.00	4.12	3.91
Protein Content (%)	3.97	3.90	4.11	4.16	4.39	4.11

Note: P0= 0% citronella ark block. P1= 2% of the total ration. P2= 4% of the total ration. P3= 6% of the total ration. and P4= 8% of the total ration

Table 3. Classification of etawa crossbreed goat milk quality based on its characteristics

Characteristics	Quality criteria		
	Premium	Good	Standard
Total plate count (cfu/ml)	$<5 \times 10^4$	5×10^4 - 10^5	$>10^5$ - 2×10^5
Somatic cells (cell/ml)	<7 cx 10^5	7×10^5 - 10^5	$>10^6$ - 1.50×10^6
Protein (%)	> 3.70	>3.40 - 3.70	3.10 - 3.50
Fat (%)	> 4.00	>3.50 - 4.00	3.25 - 3.50
Dry matter (%)	> 13.00	>12.00 - 13.00	11.70 - 12.00

Source: Thai Agricultural Standard (2008)

Table 4. Average of fat content of etawa crossbreed goat milk

Period	Treatment				
	P0	P1	P2	P3	P4
I	4.48	3.71	4.59	4.24	4.89
II	3.86	5.51	5.16	6.03	5.56
III	3.95	4.05	5.03	3.91	4.70
IV	3.84	4.26	5.02	4.23	4.67
V	4.37	4.57	3.49	5.02	4.68
Total	20.50	22.10	23.29	23.43	24.50
Average±SE	4.10±0.13	4.42±0.31	4.66±0.31	4.69±0.38	4.90±0.17

Note: P0= 0% citronella ark block. P1= 2% of the total ration. P2= 4% of the total ration. P3= 6% of the total ration. and P4= 8% of the total ration

Citronella waste has a crude fiber content of 25.73%. which may influence milk fat formation. According to Ensminger (2001). milk fat content is highly dependent on the fiber content in feed. with acetic acid and butyric acid being the primary raw materials for milk fat synthesis. These acids are produced during the digestion of crude fiber in the rumen. absorbed into the bloodstream. and transported to the liver. where they are converted into fatty acids. Subsequently. these fatty acids are transported to the udder's secretion cells to synthesize milk fat.

Acetic acid plays a key role in the formation of milk fat. When the crude fiber content in the feed decreases. acetic acid production in the rumen diminishes. which leads to a decrease in milk fat content (Mustafa. Almallah. and Saadi. 2023). The production of acetic acid in the rumen is influenced by the effectiveness of rumen microbes in fermenting crude fiber into acetic acid. Ruminant cattle. including goats. rely heavily on acetic acid to synthesize milk fat in the udder glands (Yu et al., 2024). Despal et al. (2008) further supported this. indicating that insufficient crude fiber in the diet leads to lower milk fat content.

Fat content is a critical factor influencing the selling price of milk. alongside protein content (Costa. Martinelli. and Bánkuti. 2022). To be classified as premium quality. goat milk must have a fat content exceeding 4%. as defined by Thai Agricultural Standard No. 6006 (2008). In this study. the fat content of Etawa crossbreed goat milk exceeded this standard. with a minimum fat content of 3% required by SNI. The fat content of milk in the P4 treatment was 4.9%. which was higher than the results from Sukarini (2006). where feeding goats 71.70% forage (Gamal and war leaves) and 28.30% concentrate resulted in a milk fat content of 4.86%.

Lactose Content in Etawa Crossbreed Goat Milk

Lactose is the primary carbohydrate in milk. and it is hydrolyzed into glucose and galactose in the body. These sugars are then absorbed through the intestinal wall and enter the bloodstream. The enzyme lactase is responsible for this hydrolysis process. High lactose levels influence fluid secretion into the milk. helping to maintain its osmotic pressure (Antanaitis et al., 2024). Eldeib (2025) notes that goat milk has slightly less lactose than cow milk. and the smaller fat globules in goat milk facilitate digestion. Furthermore. the protein in goat milk has higher nutritional value compared to that in cow milk. The average lactose content of Etawa Crossbreed goat milk fed with citronella block is presented in Table 5.

Protein Content of Etawa Crossbreed Goat Milk

The average protein content of Etawa crossbreed goat milk fed with citronella ark blocks is presented in Table 6. The results of the variance analysis on milk protein levels indicated no significant effect (P>0.05). The average protein levels across the treatments ranged from 3.95% to 4.16%. As shown in Table 5. administering 8% citronella ark block (P4) resulted in a decrease in milk protein levels to 4.09%. which is lower compared to the other treatments. Several factors can influence protein quality. including the lactation period. This is in line with the findings of Jarmuji (2021). who reported that administering Sakura Blok (300-900 g) to lactating FH cows had no effect on milk production and quality. The lowest milk protein content is typically observed during the third lactation period. while the highest occurs during the first lactation period (Jarmuji et al., 2021). In contrast. high-quality feed provides more significant nutrients in the bloodstream. which positively correlates with the milk formation process in the secretory cells of the mammary gland. This. in turn. can enhance both the production and quality of milk (Pan et al., 2023).

Table 5. Average lactose content etawa crossbreed goat milk

Period	Treatment				
	P0	P1	P2	P3	P4
I	3.92	3.73	3.93	3.76	3.95
II	3.85	4.13	3.65	3.68	2.51
III	3.87	3.93	3.61	3.80	3.69
IV	4.62	4.01	3.95	4.06	4.37
V	4.07	4.18	3.78	3.75	3.86
Total	20.33	19.98	18.92	19.05	18.38
Average±ES	4.07±0.14	4±0.08	3.78±0.07	3.81±0.06	3.68±0.31

Note: P0= 0% citronella ark block. P1= 2% of the total ration. P2= 4% of the total ration. P3= 6% of the total ration. and P4= 8% of the total ration

Table 6. Average protein content etawa crossbreed foat milk

Period	Treatment				
	P0	P1	P2	P3	P4
I	4.09	3.89	4.10	3.91	4.12
II	4.02	4.29	3.79	3.81	3.90
III	4.01	4.10	3.78	3.97	3.85
IV	4.83	4.18	4.11	4.24	4.58
V	4.25	4.36	3.95	3.84	4.02
Total	21.20	20.82	19.73	19.77	20.47
Average±SE	4.24±0.15	4.16±0.08	3.95±0.07	3.95±0.08	4.09±0.13

Note: P0= 0% citronella ark block. P1= 2% of the total ration. P2= 4% of the total ration. P3= 6% of the total ration. and P4= 8% of the total ration

The use of citronella ark block in treatment P4 was higher compared to treatments P1, P2, and P3. However. the results from treatment P1 yielded better quality milk than the other treatments. Treatment P4. which involved a larger dose of citronella ark block. enhanced the energy availability for forming amino acids derived from microbial proteins in the rumen. This increased availability of amino acids can contribute to more efficient milk protein synthesis (Sukarini. 2006).

This finding is further supported by Zaidemarmo et al. (2016). who observed that the increase in milk protein synthesis was attributed to the greater availability of amino acids in the feed.

Although the results regarding the protein content of Etawa crossbreed goat milk did not show a significant effect. the protein content for the P1 treatment (4.16%) was higher than the findings of Sukarini (2006). who reported that feeding a diet consisting of 71.70% forage (Gamal and war leaves) and 28.30% concentrate resulted in a protein content of 3.64% in Etawa crossbreed goat milk. This result is similar to the study by Asminaya (2007). which reported that protein content in goat milk ranges from 3.22% to 3.89%. Notably. the protein content in this study exceeds the Indonesian National Standard (01-3141-2011). which sets a minimum protein level of 2.8%.

CONCLUSION

The results indicated that the administration of citronella ark block to Etawa crossbreed goats had no significant effect on milk quality. including fat. lactose. and protein content ($P > 0.05$). However. the fat and protein contents of the milk met the quality standards outlined by the 2011 National Standardization Agency (SNI). which requires a minimum of 3.00% milk fat and 2.8% milk protein.

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