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# The Effect of Different Farm Altitudes on The Production, Quality, and Mineral Contents of the Etawa Crossbred Dairy Goat's Milk

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**ABSTRACT**

The present study aims to determine and compare the production, quality, and mineral content of Etawa crossbred dairy goat milk at various altitudes, such as the lowland, medium, and highlands of West Sumatra, Indonesia. The data were collected through laboratory tests and direct observations of livestock companies in each selected region. These regions included Padang (9 meters above sea level or MASL), Payakumbuh City (516 meters above sea level or MASL), and Agam Regency (1100 meters above sea level or MASL), representing the lowland, medium plain area, and highlands, respectively. The study used 30 lactating Etawa crossbred dairy goats. Furthermore, the parameters measured included environmental conditions (temperature, humidity), feed consumption, milk production, and quality, which consisted of fat, protein content, specific gravity, lactose, pH, dry matter, and macro and micro minerals in milk. The results showed that the milk production and ration consumption in the highlands was significantly ($P<0.05$) higher than in the medium plain and lowlands. Conclusively, differences in altitude cause differences in consumption, production, and quality of Etawa crossbred dairy goat's milk.

**Keywords:** Altitude, Etawa crossbred dairy goat, Highland, Milk production and quality.

## INTRODUCTION

Goats are among the most common ruminant livestock kept by Indonesians. They are biologically quite prolific, adaptable to various climatic conditions, and simple to maintain and develop. Their adaptability to different environmental conditions and reasonably high economic value make goats very attractive to the public. In addition to being meat-producing livestock, goats are milk-producing. One of the milk-producing goats is the Etawa crossbred dairy goat, a cross between the Etawa goat from India and the Kacang goat, which is a dual-purpose animal that produces milk and meat, hence, enhancing the economy. Another reason for developing these goats is their fast-growing nature and the litter size of up to two goat kids (Rosartio et al. 2015). Arief et al. (2021a) state that the Etawa crossbred dairy goat maintenance is easy. It does not require a large land area, and milk production and nutritional content are relatively high.

The rapid development of Etawa crossbred dairy goats has driven the breeders to select a location that does not account for optimal altitude associated with the environmental temperature. This situation can cause these goats to reach their maximum capacity for milk production. Some breeders in West Sumatra decided to raise Etawa crossbred dairy goats in the highlands, while some prefer the lowlands. The lowland selection was due to the community's economic situation, which prevented land opening for goat farming and aimed to bring the dairy goat business closer to the market. Furthermore, the altitude of the place is related to environmental temperature, production, and availability of forage feed. Thus, it will indirectly affect feed consumption, milk production, and quality. These dairy goats prefer a temperature between 24 to 27°C (Novak et al. 2000).

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According to Broucek et al. (2006), altitude impacts livestock's ability to adapt to their surroundings.

In addition to milk production, its quality is an essential aspect of the Etawa crossbred dairy goat farming business. Arief et al. (2021b) stated that several factors, including feed, breed, and altitude above sea level, influence goat's milk quality. Feed is a source of energy and nutrients needed for milk production. Hence, good quality feeds significantly increase livestock productivity. Based on the description above, a study was needed to determine the effect of different environmental conditions in the lowlands, medium, and highlands on the production and quality of goat's milk in West Sumatra, Indonesia. The results are expected to be used as a reference for developing Etawa crossbred dairy goats in Indonesia.

## MATERIALS AND METHODS

### Ethical Approval

The research ethics committee Faculty of Medicine Universitas Andalas, to protect the human rights and welfare of medical/health research subjects, has carefully reviewed the research protocol number: 115/UN.16.2/KEP-FK/2023.

### Location

Laboratory tests and direct observations were conducted on three Etawa crossbred dairy goat farming companies at different altitudes. They include Elfitra Farm in Padang, 9 meters above sea level (MASL), Toni Farm in Payakumbuh at 516 MASL, and Rantiang Ameh at 1.100 MASL, representing the low, medium, and highlands, respectively. The Google Earth platform (global positioning system/GPS assisted) was used to measure the altitude of places. Furthermore, the milk quality test was carried out at Payakumbuh's State Agricultural Polytechnic Laboratory. The Macro and micro mineral contents of milk were carried out in the Environmental Engineering Laboratory, Faculty of Engineering, Andalas University, Padang.

### Experimental Animals and Feed

This study used 10 Etawa crossbred lactating dairy goats in their $2^{nd}$ lactation at each location. The same type of concentrate and forage were offered to goats kept in the lowland, medium, and highland regions. Etawa crossbreeds dairy goats were given forage consisting of Tithonia (*Tithonia diversifolia*), native grass, and bush. The concentrate consisted of tofu waste, rice bran, and minerals. The ratio of forages with concentrates was 70:30. The composition of the feed ingredients and the nutritional composition of the ration are presented in Table 1.

### Milk Production and Quality Tests

Milk production was measured by recording the quantity produced from the morning and evening milking of 10 Etawa crossbred dairy goats per location. The parameters in the quality test are proteins, fat contents, specific gravity, dry matter, lactose, solid non-fat (SNF), pH, and micro and macro minerals. The samples tested were milk from the morning and evening milking. The milk was placed in sterile bottles in a cool box and brought to the laboratory for testing.

**Table 1:** Composition and nutritional content of the ration

| Feedstuff | Composition (% dry matter) |
|---|---|
| Native grass and bush | 60 |
| *Tithonia diversifolia* | 10 |
| Tofu waste | 15 |
| Rice bran | 14 |
| Mineral | 1 |
| Total | 100 |
| Nutrient Composition (%) | |
| Dry Matter | 49.02 |
| Organic Matter | 88.62 |
| Crude Protein | 15.96 |
| Crude Fiber | 20.68 |
| NDF | 60.36 |
| Crude Fat | 04.39 |
| TDN | 65.45 |
| NFE | 47.59 |
| Ash | 11.38 |
| Lignin | 07.69 |

Neutral detergent fiber, Total digestible nutrient (TDN), Nitrogen free extract (NFE).

### Parameters Observed and Measured

Parameters observed and measured in this study were environmental topography (temperature and humidity), nutrient consumption, milk production, quality, and mineral contents. Other parameters included the production of milk quality. Proximate analysis (AOAC 2005) was used to analyze feed ingredients' nutrient contents, such as dry matter, crude proteins, and crude fibers. LACTOSCAN MCC50 measured milk proteins, lactose, fat, SNF, dry matter, and specific gravity. The pH was measured with EUTECH INSTRUMENTS pH 700 device, and the phosphorus was using the Kjeldahl method, ultraviolet (UV)-visible (SHIMADZU) spectrophotometer with a wavelength of 889 nm, and titration method. Other minerals were measured using the atomic absorption spectrophotometer with a wavelength of Potassium (K, 766.5 nm), Calcium (Ca, 422.7 nm), Magnesium (Mg, 265.2 nm), Sulfur (S, 666 nm), Iron (Fe, 248.3 nm), Copper (Cu, 323.7 nm), Manganese (Mn, 279.5 nm), and Zinc (Zn, 213.9 nm). Feed consumption is calculated based formula of Pazla et al. (2021a):

Feed Consumption (Kg) = Feed Given – Remaining Feed

### Data Analysis

This study used the general linear model method to compare milk production and quality in dairy goat farms located in three areas at different altitudes. The data were analyzed with the study concluded analysis of variance using IBM SPSS statistics Version 26.0. Duncan Multiple Range Test (Steel and Torrie 2022) was used to determine the differences between treatments.

## RESULTS

### Temperature and Humidity

The study location, Rantiang Ameh Farm in Nagari Bukik Batabuah, Canduang District, Agam District, is a highland area. Furthermore, Payakumbuh is a medium plain, while Tabing Banda Gadang Village, Nanggalo District, Padang City, is a lowland area. These sites show different locations and environmental conditions, as shown in Fig. 1 and Table 2.

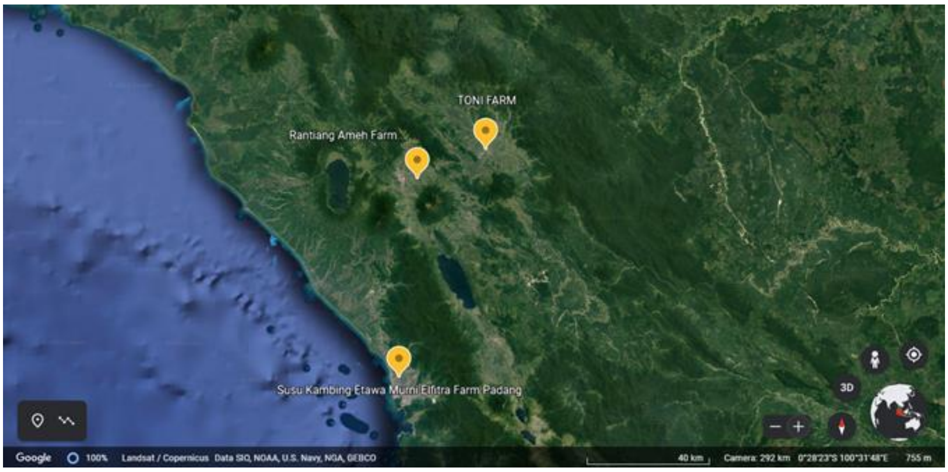


**Fig. 1:** Google Earth (https://earth.google.com/web) capture of farm location of milk sample collection: Elfitra Farm (9 MASL, lowland) at Padang; Toni Farm (516 MASL, medium) at Payakumbuh; Rantiang Ameh Farm (1100 MASL, highland) at Agam.

**Table 2:** Air temperature and humidity at research sites at different altitudes

| Environmental Aspects | Locations | | |
|---|---|---|---|
| | Lowland (9 MASL) | Medium (516 MASL) | Highland (1100 MASL) |
| Temperature (ºC) | 27.90±1.03c | 26.10±1.06b | 23.17±1.11a |
| Humidity (%) | 80.21±1.13c | 75.29±1.16b | 73.52±1.10a |

Values (mean+SD) bearing different alphabets in a row differ significantly (P<0.05). # MASL: meter above sea level

**Table 3:** Daily nutrient consumption at different altitudes

| Types of nutrients consumed/day | Units | Location | | |
|---|---|---|---|---|
| | | Lowland (9 MASL) | Medium (516 MASL) | Highland (1100 MASL) |
| DM of forage | kg | 0.98±0.03a | 1.46±0.04b | 1.86±0.02c |
| DM of concentrate | kg | 0.79±0.04a | 0.89±0.07b | 0.86±0.06b |
| DM total | kg/day | 1.77±0.04a | 2.35±0.05b | 2.71±0.04c |
| FCP | g | 100.31±2.47a | 149.34±2.23b | 348.04±2.79c |
| CCP | g | 173.01±2.58b | 123.18±2.78a | 171.91±2.66b |
| TCP | g | 273.32±2.11a | 272.52±2.43a | 519.95±2.21c |
| FCF | g | 249.44±2.77a | 371.38±3.05b | 382.19±2.55c |
| CCF | g | 66.04±1.39a | 189.48±1.98c | 162.42±1.87b |
| TCF | g | 315.49±1.98a | 560.86±1.78c | 544.61±1.79b |
| FTDN | g | 563.99±2.85a | 839.69±3.09b | 1129.51±4.09c |
| CTDN | g | 587.05±2.43b | 568.89±2.17a | 637.80±3.54c |
| TTDN | kg | 1.15±0.08a | 1.41±0.06b | 1.77±0.07c |

Values (mean+SD) bearing different alphabets in a row differ significantly (P<0.05). DM: dry matter, FCP: Forage crude protein, CCP: Concentrate crude protein, TCP: Total crude protein, FCF: Forage crude fiber, CCF: Concentrate crude fiber, TCF: Total crude fiber, FTDN: Forage TDN, CTDN: Concentrate TDN, TTDN: Total TDN.

The environmental temperature and humidity showed a significant (P<0.05) difference. The environmental temperature and humidity of the lowland are significantly (P<0.05) higher than the medium and highlands.

### Nutrient Consumption

Statistical analysis of crude protein consumption showed a significant (P<0.05) difference (Table 3). Goats consumption of crude proteins in the highland was 66.94% from forage, while the medium and lowland was 40.22%. This result indicates that goats in the highlands consume *T. diversifolia* as forage more than in low and medium lands. *T. diversifolia* is a better source of crude protein than forage in low and medium lands. The consumption of crude protein is calculated to meet the nutrition requirements of goats. Furthermore, the average consumption of crude fiber in the lowland was lower than in the highland and medium (P<0.05).

The average energy consumption in the form of TDN in goats in high, medium, and lowlands were 1.77, 1.41, and 1.15kg/day, respectively (Table 3). The statistical analysis showed that the energy consumption of goats in the highland was higher than in the medium and lowlands (P<0.05).

### Milk Production, Quality and Minerals

The average production of goat's milk in the highland area is 1.35kg/day (Table 4). Based on the statistical analysis, milk production in the highland is higher (P<0.05) than in the medium and lowlands, which are 1.29 and 1.27kg/day, respectively. Similarly, the fat, protein, and dry matter contents of goat's milk in the highland were also higher (P<0.05) as shown in Table 5. The results showed that the specific gravity and protein contents of goat's milk in the highland was higher (P<0.05) as shown in Table 5. Altitudes cause differences in the milk mineral content (P<0.05) (Table 6). Based on the results of statistical tests, the highest milk mineral of milk was found in the highland area followed by medium and lowland, respectively.

### Production Levels of Milk Quality

Altitudes cause significant (P<0.05) difference in dry matter contents of milk produced (Table 7). Based on the results of statistical analysis, the highest dry matter production of milk was found in the highland area (248.05g/head/day) followed by medium (229.62g/head/day) and lowland (182.372g/head/day).

**Table 4:** Milk production (MP) of Etawa crossbreeds dairy goat at different altitudes

| Parameter | Location | | |
|---|---|---|---|
| | Lowland (9 MASL) | Medium (516 MASL) | Highland (1100 MASL) |
| MP (liters/day) | 1.23±0.05a | 1.27±0.03a | 1.33±0.03b |
| MP (kg/day) | 1.27±0.04a | 1.29±0.03a | 1.35±0.02b |
| MP (4% FCM) | 1.29±0.04a | 1.22±0.03a | 1.41±0.02b |

Values (mean±SD) bearing different alphabets in a row differ significantly (P<0.05). #MP: Milk production; FCM: Fat correction milk

**Table 5:** Milk quality at different altitudes

| Parameter | Location | | |
|---|---|---|---|
| | Lowland (9 MASL) | Medium (516 MASL) | Highland (1100 MASL) |
| DM (%) | 14.36±0.61a | 17.80±0.89b | 18.65±0.75c |
| WC (%) | 85.56±0.61c | 82.04±0.89b | 81.01±0.75a |
| Proteins (%) | 6.61±0.03a | 6.78±0.02c | 7.22±0.02b |
| Fat (%) | 4.19±0.03a | 3.58±0.02a | 4.32±0.01b |
| Lactose (%) | 4.85±0.02a | 5.83±0.01c | 5.35±0.03b |
| SNF (%) | 10.21±0.05a | 15.66±0.06c | 14.55±0.06b |
| SG | 1.031±0.01 | 1.030±0.01 | 1.032±0.01 |
| pH | 6.8±0.02 | 6.6±0.03 | 6.7±0.02 |

Values (mean±SD) bearing different alphabets in a row differ significantly (P<0.05). DM: dry matter, WC: water content, SG: specific gravity

**Table 6:** Mineral content of milk at different altitude

| Parameters | Units | Lowland (9 MASL) | Medium (516 MASL) | Highland (1100 MASL) |
|---|---|---|---|---|
| Macro minerals (%) | P | $0.18±0.0011^a$ | $0.19±0.0013^b$ | $0.21±0.0017^c$ |
| | K | $0.16±0.0025^a$ | $0.16±0.0043^a$ | $0.17±0.0071^b$ |
| | Ca | $0.16±0.0013^a$ | $0.17±0.0023^b$ | $0.19±0.0035^c$ |
| | Mg | $0.10±0.0021^a$ | $0.11±0.0019^a$ | $0.13±0.0011^b$ |
| | Na | $0.40±0.023^a$ | $0.43±0.0017^b$ | $0.47±0.0035^c$ |
| Micro minerals (ppm) | S | $0.0244±0.0009^a$ | $0.0277±0.0008^b$ | $0.0278±0.0007^b$ |
| | Cu | $0.0363±0.0007^a$ | $0.0440±0.0007^b$ | $0.0441±0.0002^b$ |
| | Zn | $0.0588±0.0007^a$ | $0.0865±0.0006^b$ | $0.0878±0.0003^c$ |
| | Mn | $0.0425±0.0004^a$ | $0.0611±0.0005^b$ | $0.0744±0.0002^c$ |
| | Cd | $0.0422±0.0001^a$ | $0.0487±0.0002^b$ | $0.0512±0.0003^c$ |
| | Fe | $0.1048±0.0002^a$ | $0.1370±0.0003^b$ | $0.1371±0.0002^b$ |

Values (mean±SD) bearing different alphabets in a row differ significantly (P<0.05).

**Table 7:** Production levels of milk quality at different altitudes

| Production levels of milk quality (g/head/day) | Location | | |
|---|---|---|---|
| | Lowland (9 MASL) | Medium (516 MASL) | Highland (1100 MASL) |
| DM | 182.37±3.46a | 229.62±4.04b | 248.05±3.01c |
| Protein | 12.05±0.76a | 15.57±0.81b | 19.15±0.65c |
| Fat | 7.64±0.23a | 8.22±0.25a | 10.72±0.27b |
| SNF | 18.55±0.19a | 32.65±0.21b | 35.54±0.31c |

Values (mean±SD) bearing different alphabets in a row differ significantly (P<0.05). DM: dry matter, SNF: solid non-fat

Due to high dry matter consumption, the dry matter production of highland milk is higher than medium and lowland. This is also caused by differences in the efficiency of feed used, the mechanism of milk synthesis, and environmental temperature. The medium area has a higher dry matter consumption than the lowland, but the difference in milk production was non-significant (P>0.05).

Different altitudes affect the production of milk protein contents (P<005) as shown in Table 7. Based on statistical results, the highest production of milk protein contents were in Agam Region (19.15g/head/day), followed by Payakumbuh (15.57g/head/day) and Padang (12.05g/head/day). Milk fat was also the highest (P<0.05) in the highland at 10.72g/head/day, followed by the medium and lowland at 8.22 and 7.64g/head/day, respectively (Table 7). The SNF levels in milk at different altitudes gave varying results, being the highest (P<0.05) in milk produced in the highland at 35.53g/head/day, followed by the medium and lowlands at 32.65 and 18.55g/head/day, respectively.

## DISCUSSION

### Temperature and Humidity

The environmental temperature and humidity of the Padang (lowland) are higher than the Payakumbuh (medium) and Agam (highland). According to Payne (1970), the average daily air temperature decreases by 1.7ºC for every 305 MASL increase in altitude. The difference in altitude, which is about 500 MASL between the lowland, medium, and highland locations, causes differences in air temperature and humidity. Handoko (1995) stated that the farther from the sea surface, the less the number of air molecules and the lower the collisions, resulting in a cooler air temperature. Microclimate conditions, incredibly different environmental temperatures due to differences in altitude, can affect livestock production. Furthermore, unsuitable microclimate conditions can inhibit the normal physiological process of animals, ultimately reducing their optimum production (Konyves et al. 2017).

**Nutrient Consumption**

Goats consume more feed in the highlands because their body temperature equalizes with the ambient temperature. Consumption of forage containing *T. diversifolia* is very helpful in digesting feed so that the rumen is emptied more quickly (Pazla et al. 2022; Arief and Pazla 2023). This condition will encourage goats to consume more feed. *T. diversifolia is* reported to contain high P minerals (Adrizal et al. 2021). *T. diversifolia* grows in the highlands and contains anti-nutritional substances, such as phytic acid, which binds phosphor. The phytic acid content of the tithonia plant is 79.2mg/kg (Oluwasola and Dairo 2016). Furthermore, the phytic acid that enters the rumen will be degraded by microbes, which produce phytase enzymes, thereby allowing the release of bound phosphorus into available form (Pazla et al. 2021b; Pazla et al. 2021c). Mineral P is needed by rumen microbes for microbial protein activity and synthesis (Pazla et al. 2018a; Pazla et al. 2018b; Suyitman et al. 2020; Suyitman et al. 2021). This variation is caused by the type of feed provided and the soil nutrient content in each area absorbed by forage plants (Jamarun et al. 2020).

The high consumption of crude fiber can affect the fat content of goat's milk. Owns and Basalan (2016) stated that the ratio of feed containing more forage causes rumen microbes to convert carbohydrates into 65% acetic acid, 20% propionic acid, and 15% butyric acid. This conversion affects the adequate supply of acetate to maximize milk fat production (Anzhany et al. 2022). The energy requirement in the form of TDN is 18.91g/kg BW (National Research Council 1981). Based on these data, the energy consumption of goats in the highland is the highest and the lowest is in the lowland.

These results indicate that the various altitudes influence the nutrients consumed by the goat. Forage feed consists primarily of leaves and has become a better source of nutrients to meet the needs of dairy goats. According to Nugroho et al. (2013), the amount of TDN consumption is influenced by the nutrients in the feed ingredients. This is because TDN is the amount of energy that can be digested from the nutrient content of the feed.

**Milk Production**

In the present study it was observed that the frequency of milking affects the production of milk. According to Martinez et al. (2017), milk production increased by 19.61% in goats milked twice daily compared to once. The standard of goat milk production in 4% FCM (fat-corrected milk) in the highland was higher (Table 4). Furthermore, highland daily temperature and humidity of 23.17ºC and 73.52%, respectively, are more comfortable for goats than lowland and medium, which have higher temperatures. These results indicated that temperature affects the milk production of Etawa crossbred dairy goats. Novak et al. (2000) stated that the comfort zone temperature for dairy goats for normal production ranges from 24 to 27˚C. Due to variations in altitudes, environmental differences, especially microclimate conditions, can vary in each region. Inappropriate macro climatic conditions can act as an inhibiting factor for the normality of livestock physiological processes, ultimately suppressing their ability to produce milk and meat (Allen et al. 2018; Narmilan et al. 2021). The feed in the three locations was the same, but due to differences in ambient temperature, the feed consumption was different. According to Arief et al. (2020), many factors affect milk production, but feed consumption has a significant effect on milk production. According to Larson (1979), milk production depends on ingredients in the blood, which relies on the efficiency of the feed consumed. Milk production also depends on the mechanism of milk synthesis, particularly the availability of enzymes involved, despite the relatively high level of ingredients derived from foods consumed (Mayne and Gordon 1984).

**Milk Quality**

The protein contents in the present study were higher than those reported by Jamarun et al. (2020), which was 4.39%. However, the fat content met the standards of goat's milk according to the Thai Agricultural Standard (2008), which was >4%. The difference in milk fat contents in the three locations could be attributed to the consumption of the goats. The reports of Calderon et al. (1984) indicated that milk fat usually increases by 7-20% when the concentrates are given. The high protein content of the concentrate stimulates the synthesis of propionic acid production in the rumen, which is then absorbed into the bloodstream. The high-fat content in goat's milk in the highland could be due to the high proportion of grass in the forage feed that improves consumption. In addition, the level of milk protein in the three locations was within the normal range according to the Thai Agricultural Standard (2008). Various factors are known to influence the chemical composition of milk, and the environmental temperature is affected by the altitude above sea level. The higher the area from sea level, the lower the environmental temperature. Different temperatures can affect milk's chemical composition (Yano et al. 2014). In the present study, the specific gravity of goat's milk from other locations remained within the normal range, consistent with the reports of Arief et al. (2021) and Guzeler et al. (2010), who reported the specific gravity of milk from 1.028 to 1.033. Parmar et al. (2020) stated that temperature could affect the specific gravity of milk.

The mineral content of milk (Table 6) is related to the mineral content of the feed. The high consumption of dry matter can affect the mineral content of goat's milk. The high-mineral content in goat's milk in the highland is due to the high nutrient consumption. The mineral content of milk in the three regions is almost the same as that obtained by Kędzierska-Matysek et al. (2015).

**Production Levels of Milk Quality**

The variations in the production of the dry matter content of milk are caused by differences in milk production and components, such as fat content and SNF. The milk consists of two components, namely fat and SNF, composed of three parts: lactose, nitrogen fraction (NPN and protein), as well as minerals and vitamins (Magan et al. 2021). According to Arief et al. (2018), the dry matter content of milk depends on the nutrients consumed by livestock, which are then used as precursors for forming dry matter or milk solids. The dry matter milk production in this study was higher than Budi (2002) reported, which was 57.66-91.76g/head/day, and contained 14.75-15.80% milk dry matter. It is also higher than Asminaya (2007) reports of 56.98-114.47g/head/day with 15.07-16.8% milk dry matter. Additionally, the milk dry matter production in the highland was higher than 162.16g/head/day, with 16.38% milk dry matter.

The protein synthesis of milk comes from amino acids circulating in the blood due to the absorption of nutrients from the digestive. It is also caused by the overhauling of body proteins and amino acids synthesized by epithelial cells of the mammary glands (Larson 1979). The production of milk protein content in this study was higher than in Asminaya (2007) report of 1.84-5.5g/head/day, with a milk protein content of 3.13-3.96%. According to Atabany (2001), the production of milk protein content in the Barokah farm is 4.75g/head/day, which has a protein content of 2.93%. A higher forage ratio in the highland, leads to higher acetic acid. According to Despal et al. (2021a), the acetic acid formed in the rumen is the primary raw material for forming various fatty acids from milk fat. Furthermore, reduced acetic acid decreases milk fat synthesis and content. Another factor that causes higher milk fat production in highlands is the fat content in their feed. Despal et al. (2021b) stated that about 50% of milk fat comes from short-chain fatty acids (C2-C4), synthesized in the udder from acetic acid and beta-hydroxybutyrate. In addition, about 50% comes from long-chain fatty acids (C16-C18), emanating from the fat present in feed and body fat reserves. Lowland and medium produced the same amount of milk fat because body fat reserves are used to produce fat milk levels. Lowland is also suspected of using body fat reserves because its conditions have a lower forage ratio than goats in lowland and highland.

The crude fiber consumption in the lowlands is also lower than in the medium and highlands. The production of milk fat content in this study is higher than Asminaya (2007) report of 2.85-12.61g/head/day, with a fat content of 5.39-7.18%. The fat content of goat's milk from the highland was higher than the Etawa Crossbreeds at Barokah farm, which was 10.83 g/head/day with 6.68% fat content (43). In this study, the production of milk SNF levels was higher than Asminaya (2007) result of 4.77-12.11g/head/day with 9.2-9.7% milk SNF. According to Atabany (2001), SNF levels in Etawa crossbred dairy goat's milk production in Barokah farms is 15.71g/head/day with 9.69% milk SNF.

## Conclusion

Differences in altitude cause differences in consumption, production, and composition of Etawa crossbred dairy goat's milk. Etawa crossbred dairy goats in the highlands showed higher milk production, protein, fat and mineral content. Conclusively, the quality of milk produced from the three regions in different altitudes follows the nutritional standards of goat's milk.

## Author's Contribution

Arief, Novirman Jamarun, and Roni Pazla designed the concept, searched for funding, and drafted and reviewed the paper. Rahmani Welan and Gusri Yanti supervised the field and laboratory work. Rani Winardi Wulan Sari conducted field and laboratory work and data tabulation.

## Competing Interest

All of the authors declare that they have no competing interests.

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