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A comparative study among dairy goat breeds in Lumajang and Malang (East Java, Indonesia) based on milk organoleptic and milk composition

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Abstract. *Fatmawati M, Suwanti LT, Mufasirin, Hambarruk W, Sukesi LE, Rofiah, Novianto E, Wahyuningtyas BK. 2022. A comparative study among dairy goat breeds in Lumajang and Malang, East Java based on milk organoleptic and milk composition. Biodiversitas 23: 2899-2903.* The Regencies of Lumajang and Malang have the potential for local dairy goats to support food security and food safety. In Lumajang and Malang there are a diversity of dairy goats that breed Senduro, Crossbreed Etawa, Sapera, and Menggolo. This study aimed to compare the milk quality of various breeds of dairy goats in Lumajang and Malang regencies based on organoleptic and composition tests. The total sample was 161 milk samples from Lumajang (115 dairy goats) and Malang (56 dairy goats). The organoleptic test of milk was carried out by testing the freshness, smell, taste, viscosity, and color of the milk. The milk composition test used lactoscan. The analysis consisted of the Chi-Square test for organoleptic and the Kruskal Wallis for milk composition test. The results show that the quality of goat's milk is of premium quality. The order of milk quality based on fat content is milk from Menggolo, Senduro, Etawa, and Sapera breeds. This study concluded that the breed of dairy goat influence the composition and quality of goat's milk. The milk quality of all dairy goat breeds from Lumajang and Malang was premium quality, but the Menggolo goat is the best, so it can be developed to increase local food productivity.

Keywords: Food productivity, food security, genetic diversity, milk quality

INTRODUCTION

The concept of food security is developing regional potential as a source of fulfilling basic human needs. Milk is a food source of animal origin needed for child growth (Muehlhoff et al. 2013; Herber et al. 2020). But on the other hand, other protein sources are found in other mammals, such as goat's (*Capra aegagrus hircus*) milk. Goat's milk is an alternative source of animal protein because it is safe for lactose-intolerant in humans and useful for various degenerative disease prevention (Chauhan et al. 2021). Goats are livestock mostly kept by farmers because their maintenance system is relatively easier than cows. But specifically, dairy goats have not been widely developed. From economic analysis, the sale of expensive goat's milk can benefit farmers more.

Data for 2018 to 2020 shows that East Java is the highest fresh milk producer in Indonesia, respectively, 512 846.75 tons, 521,123.43 tons, and 534,151.52 tons in 2018, 2019, and 2020 (BPS 2022). This fresh milk is produced from dairy cows and dairy goats, although goat's milk production is very small. For example, dairy milk production from cows and dairy goats, respectively 77 tons and 3796.03 tons in East Java Province in 2017 (BPS 2019). Lumajang and Malang are regencies/cities in East Java province that produce goat's milk. In 2013 the Etawa Crossbreed (PE) Goat was designated as a local Indonesian goat family through the Decree of the Minister of Agriculture Number 695/Kpts/PD.410/02/2013 (Indonesia Agency for Agriculture Research 2019). As a dairy goat, the PE goat is suitable for keeping in almost all parts of Indonesia, including in Lumajang and Malang, East Java (Sumartono et al. 2016). Besides the PE, in Lumajang, there is also a superior local dairy goat, namely Senduro (Ciptadi et al. 2019; Rifa'i et al. 2021).

The benefits of goat's milk are improving health include increasing immunity, improving digestion, lowering cholesterol, reducing diabetes, treating gout, reducing high blood pressure, overcoming stomach acid, reducing the risk of stroke, increasing endurance and the immune system, treating respiratory problems, and nourishing the lung (Clark et al. 2017). Goat's milk is good for health because of its fat content, namely MCT (Medium Chain Triglyceride), which can treat ulcers and digestive tract

diseases (Bhattarai 2014; Albenzio et al. 2021). The advantage of goat's milk compared to milk from other mammalian species is that goat's milk contains higher Ca, Mg, and P than milk from different animal breeds (Clark et al. 2017). The fat globules of goat's milk are smaller than cow's milk, so in terms of the production efficiency of milk processing, there is no need for homogenization of goat's milk as for processing cow's milk (Hammam et al. 2021).

There are no quality standards for goat's milk in Indonesia. However, the Thai Agriculture Standard/TAS (2008) has determined the criteria for fresh goat's milk quality. The criteria are premium, good and standard and the criteria consist of total count (cfu/mL), somatic cells (cell/mL), protein (%), fat (%) and total solid (%). Review by Chauhan et al. (2021), and Park (2007), explained that goat's milk composition includes 3.8% fat, 3.4% protein, 4.1% lactose, 0.8% minerals, 8.9% total solid non-fat, and 87% water with a pH between 6.5-6.9. Until now, there have been no reports about goat's milk quality in correlation with goat bread in Lumajang and Malang District. This paper describes the breeds of dairy goats in Lumajang and Malang and compared milk quality among breeds based on organoleptic and composition.

MATERIALS AND METHODS

Study location

The study was carried out on 31 dairy goat farms located in Lumajang and Malang, that were 19 farms in Senduro subdistrict of Lumajang, 5 farms in Ampelgading subdistrict of Malang, and 7 farms in Tirtoyudo subdistrict of Malang. Milk samples were taken from farms that have lactating dairy goats. Each farmer in Lumajang District has an average of 10 to 20 dairy goats, while farmers in Malang have 2 to 6 dairy goats. The total sample used in this study was 161 milk samples. Dairy goat has collected about 200 mL of milk and then stored in a refrigerator at 4 degrees Celsius aseptically as possible. Milk quality testing was carried out one day after sampling.

Data collection and recording

The sample represents all breeds of dairy goats owned by farmers. Breed is determined based on the characteristics of the goat. Milk quality testing consists of organoleptic tests and composition tests. The organoleptic test included smell (odor), color, viscosity, flavor, clearness, boiling test and alcohol test. The composition test using lactoscan. Quality traits included fat percentage (FAT%), solid non-fat percentage (SNF%), protein, lactose, mineral, and conductivity.

Composition measurement

There is no standard composition of goat's milk in Indonesia. Based on TAS 2008 and fresh milk quality standard from Indonesia National Standard (SNI) number 3141.1.2011, the quality grading of raw milk according to its characteristic in this Table 1.

Statistical analysis

The organoleptic milk data were categorized based on the Grading quality of goat's milk (Table 1). The difference between species and organoleptic tests was analyzed using the Chi-square test with a confidence level of 5%. In contrast, the difference between goat breeds and milk composition was analyzed using Kruskal Wallis with Post Hoc test using Mann Whitney test. The statistical program that uses is SPSS windows version 20.0.

RESULTS AND DISCUSSION

Dairy goat breed

This study identified four dairy goat breeds, namely: Sapera, Etawa Crossbreed, Senduro, and Menggolo, with an as shown in Figure 1. The total number of dairy goats was 161, with details of the number of each breed 4 (2%) for Sapera, 53 (33%) Etawa Crossbreed, 72 (45%) Senduro, and 32 (20%) Menggolo. The four breeds were found on a farm in Lumajang, while from a farm in Malang only three breeds were found that are Sapera, Etawa Crossbreed and Senduro. The total sample from Lumajang was 115 dairy goats and 56 from Malang.

Table 1. Grading quality of goat`s milk

Grading quality / Characteristics	SNI 3141.1.3141	TAS 2008
Milk composition		
Fat (%)	3	Premium (>4); Good (>3.5 to 4); Standard (3.25 to 3.5)
Total solid (%)	-	Premium (>13); Good (>12 to 13); Standard (11.7 to 12)
Total solid nonfat (%)	7.8	8.25
Protein (%)	2.8	Premium (>3.7); Good (>3.4 to 3.7); Standard (3.1 to 3.4)
Organoleptic test		
Smell	No changes	Normal
Color	No changes	white or cream
Viscosity	No changes	
Flavor	No changes	natural flavor without any foreign matter and adulteration
Clearness	-	clean
Boiling test		the heated milk containing acidity at or above 0.2% as lactic acid will show the sediment particle which is not suitable for further products
Alcohol test	negative	the sediment must only be in a fine small shape

The Senduro goat is a local genetic resource in Lumajang District, Indonesia, based on the Regulation of the Minister of Agriculture Number 1055/Kpts/SR.120/10/2014. Senduro breeds result from a cross between the Jamnapari Goat (India) and the Local Goat in Lumajang or Menggolo. The characteristics of the senduro goat are white color, convex face, ears long and hanging down and no horns, short tail. The male Senduro goat has a long beard. The back is slightly curved, its lowest point in the middle of the body to form an angle, and the back is higher to the hips. The female goat is beardless and has a long neck and hip hair. The average production is 1.3 to 1.8 liters per day (Ministry of Agriculture 2014).

Menggolo is a local goat in Lumajang. In this study, farmers obtained information that the dominant breed of Menggolo Goat appears with white and brown coat color characteristics. The breeders provide information that the milk production of goats with the above characteristics is higher than other dairy goat breeds, which is between 1.8 liters to 3 liters per day.

Sapera results from a cross between a Saanen goat and an Etawa goat. This goat has perfect white color, flat face, medium ears, and small horns (Sumartono et al. 2016; Rifa'i et al. 2021). Other characteristics are the ears are medium and erect, the nose is straight, and the face is like a triangle. The ears are simple, erect to the side and forward. Sapera goat tail thin and short. Sapera male and female goats with horns. Milk production is about 740 kg per lactation period (Rusdiana et al. 2015)

The most common type of dairy goat found in Lumajang is Senduro. However, Etawa Crossbreed are almost seen in Malang. For Sapera, there are not many, but there are in the two districts. For a Menggolo, they live in Lumajang District. Senduro is the leading commodity of Lumajang District for milking and (dual function). The Ministry of Agriculture developed Sapera with the main goal of producing milk. Menggolo is only found in Lumajang District. Meanwhile, other breeds are kept in Lumajang and Malang Regencies.

The organoleptic of goat's milk

The results of the organoleptic test showed that the milk from the Menggolo breed was the best because it complied with the quality standard requirements based on SNI and TAS 2008. Meanwhile, the organoleptic test for odor, smell, and the boiling test found from other breeds has a sour smell and taste with big fat granules (Table 2). The good standard for organoleptic tests for the smell (odor) was no change. Milk smell from Menggolo breeds was 32 (100%) with no change. However, milk smell from other breeds; there is a snoring smell, including Sapera 1 (25%); Etawa Crossbreed 18 (34%); and senduro 5 (5.9%). The good standard for milk color was white or cream. The organoleptic test results for cream-colored milk were 4 (100%) from Sapera; 48 (90.6%) from Etawa Crossbreed; 38 (52.8%) from Senduro; 13 (40.6%) from Menggolo. The results of the organoleptic test for white milk were 1 (1.9%) from etawa crossbreeds; 11 (15.3%) from Senduro; 14 (43.8%) from Menggolo. While the other milk shows a yellowish cream color to yellow.

The milk color comes from the conversion of carotene. Goats can convert all beta carotene into vitamin A so that the color of milk is white (Guney 2019). The color of milk depends on the type of livestock, feed, fat, solids, and color-forming materials. The white color comes from the dispersion of light reflected by fat droplets and particles of colloidal fat, calcium caseinate, and calcium phosphate (Park 2016). The yellow color is due to fat and soluble carotenoids and riboflavin (Hammam et al. 2021)

The milk flavor based on a standard of fresh milk is not changed. The study results for milk flavor showed that the Menggolo goat's milk was 32 (100%) with no change. But there is still a faded taste between 1.4% to 25% for other goat breeds. Goat's milk has a strong taste due to its short fatty acids. The chocolate flavor variant has the highest score from research on consumer preferences for goat's milk. Its means that goat's milk needs processing, such as being pasteurized or made into powder and mixed with various flavors (Agustina et al. 2021).

Composition of goat`s milk

The results of the composition test for all milk samples from various types of goat breeds showed that the milk value was above the premium qualification based on TAS 2008 (Table 3). The average composition of goat's milk consists of 6.89% fat, 4.99% protein, 3.2% lactose, 0.8% minerals, 9.015% Total Solid Non-Fat. The results showed that there were significant differences between goat breeds in milk composition (fat, protein, lean dry matter, minerals and conductivity). However, the breeds of goat do not affect the lactose content of goat milk. Goat breeds Menggolo have the highest fat content. The Senduro goat breed had the highest of lactose, protein, total solid non-fat and conductivity.

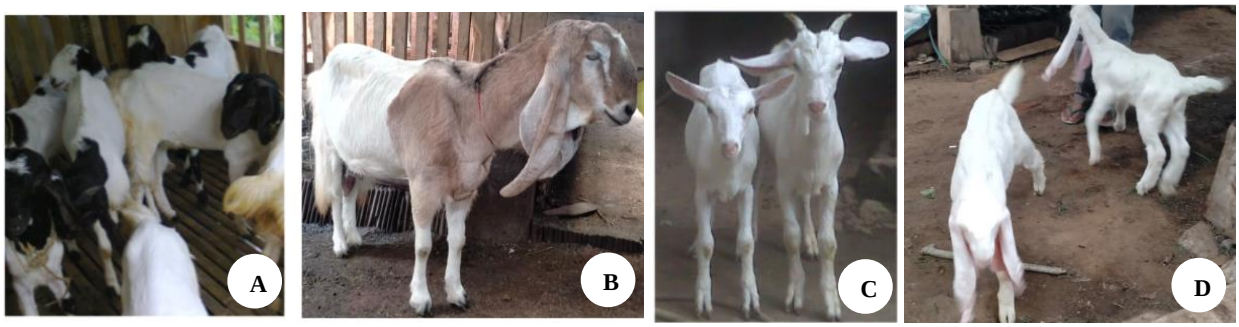

Figure 1. Breed Dairy Goats in Lumajang and Malang District A. Etawa Crossbreed; B. Menggolo; C. Sapera; D. Senduro

Table 2. Organoleptic goat`s milk based on breed

Organoleptic test	Sapera	Crossbreed Etawa	Senduro	Menggolo	P Value
Smell/odor					
- No Changes	3 (75%)	35 (66.0%)	67 (93.1%)	32 (100%)	P: 0.000
- Goat smell (brengus)	1 (25%)	18 (34.0%)	5 (6.9%)	0 (0%)	
Colour					
- Cream	4 (100%)	48 (90.6%)	38 (52.8%)	13 (40.6%)	
- Cream to Yellow	0 (0%)	0 (0%)	6 (8.3%)	0 (0%)	P: 0.000
- Yellow	0 (0%)	4 (7.5%)	17 (23.6%)	5 (15.6%)	
- White	0 (0%)	1 (1.9%)	11 (15.3%)	14 (43.8%)	
Viscosity	4 (100%)	53 (100%)	72 (100%)	32 (100%)	
Flavor					
- Specifically milk flavor	3 (75%)	47 (88.7%)	71 (98.6%)	32 (100%)	P: 0.009
- Goat flavor (brengus)	1 (25%)	6 (11.3%)	1 (1.4%)	0 (0%)	
Clearness	4 (100%)	53 (100%)	72 (100%)	32 (100%)	
Boiling test					
- Negative	4 (100%)	34 (64.2%)	72 (100%)	32 (100%)	P: 0.000
- It's look fat granule	0 (0%)	19 (35.9%)	0 (0%)	0 (0%)	
Uji Alcohol negative	4 (100%)	53 (100%)	72 (100%)	32 (100%)	

Note: *Significant at 5% level ($p<0.05$)

Table 3. Composition of goat`s milk by breed

Milk Composition/ Breed	Sapera	Crossbreed Etawa	Senduro	Menggolo	P Value	Average	Standard (Premium) TAS 2008
Fat (%)	5.44^{ab}	6.52ab	6.87a	8.74b	0.013	6.89	>4
Total Solid Non-Fat (%)	8.48^{a}	9.27^{b}	9.33^{b}	8.98^{ab}	0.005	9.02	>8.25
Lactose (%)	3.05	3.29	3.33	3.02	0.002	3.17	-
Mineral (%)	0.78^{a}	0.85^{b}	0.85^{b}	0.82^{ab}		0.83	-
Protein (%)	4.63^{a}	5.09^{b}	5.15^{b}	5.10^{b}		4.99	>3.7
Conductivity	4.31^{a}	4.95^{ab}	5.18^{b}	4.95^{ab}		4.82	-

The Menggolo goat and the Senduro goat are local goats adapted to the tropical environment. Both of these breeds can produce optimal milk production. This research aligns with Goddour et al. (2007), which state that goat production will be optimal if it can adapt to the environment. To increase the productivity of goat's milk with higher adaptability, it needed a new genetic goat breed from local goats crossed with exotic goat breeds with high milk production. Saanen goat is a goat from Switzerland which produces a high quantity of milk. However, it is less adaptable to the tropics. Saanen goats could cross with local goals to increase animal productivity, especially goat's milk.

Goat's milk has a unique fat composition. The precursor for fat formation is the initial acetate concentration present in the rumen with a primary source from fiber content in the feed (Kalyankar et al. 2016). Lumajang and Malang regencies have vast land with a lot of forage that indicates sufficient for livestock. This geographical condition supports a high average milk fat content in these regencies. Goats are livestock that is easy to maintain. Potential areas rich in forage will make it easier for livestock to provide feed to dairy goats. The vast potential of agricultural land supports agricultural activities. Availability of abundant forage becomes income for farmers. A study on the production costs of dairy goats stated that the highest cost structure was the cost of raw materials such as forage (*kaliandra*) and concentrated (Wiguna et al. 2020).

Goat milk fat depends on the breed, feed, lactation period, season, temperature, and body condition. The criteria used in developing a dairy goat farming business include use, selection of goats, management of raising livestock, labor, and physical environment (Mauladi et al. 2018). The basic feed of goats is composed of several green or stored forages (hay, silage, dried forage. De Novo's theory for milk fat synthesis said that precursors of milk fat are acetate (C_2) and hydroxybutyrate (C_4). Acetate comes from the fermentation of carbohydrates that enter the rumen. Bacteria in the rumen will produce butyric acid during the fermentation process, converted into hydroxybutyrate. Acetate and hydroxybutyrate will enter the mammary gland, and then both will be activated by Co-Enzyme A (CoA) (Clark et al. 2017). The primary fatty acid in feed is linolenic acid, primarily from forage. At the same time, concentrate and seed oil produce linoleic acid. Fatty acids will be esterized and hydrolyzed by bacteria in the rumen to produce free fatty acids. Meanwhile, free unsaturated fatty acids will undergo bio-hydrogenation because they are toxic to bacteria in the rumen, affecting fermentation speed.

Goat milk has a high biological content, such as protein non-protein nitrogen (NPN), so it is easy for the body to

digest. Goat milk protein is influenced by feed, temperature, endocrine control, milking frequency, breed differences, and lactation time. The average protein of goat's milk is 4.99% above the standard TAS 2008, 3.7%. Proteins from goat breeds from Etawa, Senduro, and Menggolo breeds were not significantly different. However, in Sapera, the average protein content is lower. Mammary glands are the place for synthesizing protein, fat, and lactose with different precursors. Protein biosynthesis depends on hormonal factors and gene expression (Ratya et al. 2017). The primary precursor of gene expression is a complex process involving the interaction of hormone-induced transcription factors and promoter regions or specific regions of DNA. Milk protein is a secretory protein that moves from milk reservoirs in the alveolar lumen of the mammary gland. Protein breakdown begins in the stomach by producing hydrochloric acid and the enzyme pepsin and ends in the small intestine (Kalyan et al. 2021). Goat's milk is hydrolyzing protein that positively affects humans (Park 2007). Goat milk also contains lactoferrin, transferring, and prolactin, increasing the body's immune system.

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