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Evaluating the milk fatty acid composition from Boerawa goats

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Abstract

Boerawa is the crossbreed goat between Boer and Etawa goats. In recent times, this type of goat is widely found in Indonesia as favorable farmed livestock. This present study aims to determine milk fatty acid profiles from Boerawa, Etawa, and Kacang goats. The samples used in this current study consist of 30 lactating goats from three different types, namely Boerawa, Etawa, and Kacang goats. Each group consists of 10 individuals, which are also considered as replications for this experiment. The livestock was managed in the same treatment condition. Profiles of fatty acids such as saturated, monounsaturated, and polyunsaturated fatty acids were identified using GC-MS methods. The data obtained were analyzed by one-way ANOVA. The results showed that saturated fatty acid (SFA) content in Boerawa goats was lower than in Etawa and Kacang goats (60% vs. 68% and 70%). However, monounsaturated fatty acid content in Boerawa goats was higher than in Etawa and Kacang goats (33% vs. 26% and 26.4%), as well as the polyunsaturated fatty acid content in Boerawa goats was higher than in Kacang goats (5.8% vs. 2.8%). This study showed that the lipid quality from Boerawa's milk has a healthier fatty acid compared with Etawa and Kacang goats. Together, these results support the use of local genetic resources through a crossbreeding program to improve the genetic quality of goats, especially the quality of the milk fatty acids.

Key words: *Boerawa, genetic improvement, MUFA, PUFA, SFA*

Introduction

Goats are small ruminants that are widely farmed by breeders in rural areas in Indonesia. The animals are generally maintained as a source of income and a socio-religious symbol. Aside from being a meat producer, most of the livestock is also employed as a milk producer that supplies nutrients to the community (Pakpahan et al 2016). Interestingly, there are two types of goats that are widely farmed in Indonesian society, namely Etawa and Kacang goats. The demand for meat and milk from goats is continuously increasing both regionally and nationally. Therefore, the productivity promotion of local goats is necessary. This approach can be undertaken by introducing feed technology and genetic improvement. Importantly, genetic improvement via crossbreeding is the most common technique to increase the quality of goats. This approach has been widely applied in Boer goats (Mahmilia and Doloksaribu, 2010). In recent times, examples of crossbreeding techniques have been employed in Boer and Etawa goats, in turn resulting in Boerawa goats (Sulastri et al 2014) and crossbreeding between Boer and Kacang goat producing the Boerka goats (Ginting and Mahmilia, 2008).

The milk produced by goats is good for human health. Goat's milk has smaller fat globules than cow's milk, making it easier to digest (Chandan et al 1992). This condition causes the goat's milk proper to consume, especially for babies and senior citizens. Goats' milk contains monounsaturated fatty acids (MUFA), polyunsaturated fatty acids (PUFA), and medium chain triglycerides that are good for health (Kompan and Komprej, 2012). This advantage allows goats' milk to be developed as a functional food that can be used for medical treatment for conditions such as malabsorption syndrome (Alferez et al 2001; Barrionuevo et al 2002; Lopez-Aliaga et al 2010).

Boer goat is a broiler goat that is specifically raised to produce meat, while Etawa goat has a dual function in producing meat and milk. The primary purpose to crossbreed Boer and Etawa goats is to enhance the growth performance and gain good quality meat. However, this crossbreed will interfere with the quality and quantity of milk production. Therefore, the purpose of this study is to identify the profile of milk fatty acids from Boerawa, Etawa, and Kacang goats, which are maintained in the same production system.

Figure 1. Boerawa doe

Figure 2. Etawa doe

Figure 3. Kacang doe

Materials and methods

The research was conducted at the Animal Science Faculty of Hasanuddin University goat experimental station (Makassar, South Sulawesi, Indonesia). Three types of goats were used in this research, namely Boerawa (group I), Etawa (group II), and Kacang goats (group III). Each group consisted of 10 goats. The experimental goats were in their second and third pregnancy and reared under the same feed and management condition until parturition. The feed was composed of legume from Indigofera sp mixed with Elephant grass (*Pennisetum purpureum*) and concentrate mixture and adjusted to meet goats' maintenance and pregnant requirements. Feed detail composition is shown in Table 1. The feed nutritional composition was analyzed using a near-infrared spectrometer NIRFlex N500. All the goats were fed twice a day and drinking water was available *ad libitum*.

Table 1. Feed Nutrition Composition

Ingredients (% of DM)		**Chemical composition (%)**	
Concentrate (40%)			
Rice bran	37	Crude Protein	14.7
Coconut cake meal	16	Fiber	5.41
Maize meal	15	Fat	6.47
Molasses	15	Ash	6.74
Shrimp waste meal	10	Moisture	13.4
Mineral mix	4	Phosphorus	0.87
Salt	3		
Total	100		
Forage (60%)			
Indigofera	20		
Elephant grass	40		
Forage/Concentrate	60:40		

Milk samples were collected on the 10th day of lactation (10 days after birth), milk samples (100 mL/goat) were then freeze-dried and stored at – 20 °C until the fatty acid analysis stage. Colostrum fatty acid content was analyzed as follows: the fat fraction was separated by extraction of fat samples according to the AOAC official method of analysis of oil and fat (AOAC, 2012).

Fatty acid methyl esters (FAMEs) of total lipids were prepared according to the AOCS Ce 2-66 standard (AOCS, 2017). The gas chromatography analysis of methyl esters was performed on a GC Clarus with FID detector (Perkin Elmer), Supelco SPTM 2560 capillary column (100 m ´ 0.25 mm ID, 0.2 μm) was used. Fatty acids were identified based on retention times of fatty acid standards. A 37-component standards FAMES mix (Supelco, Sigma-Aldrich) was used.

Data measurements were obtained in duplicate and average values of fatty acids were calculated. The variables measured were saturated fatty acid (SFA), MUFA, PUFA, omega-3, omega-6, and omega-9 fatty acids. All data obtained were analyzed using one-way ANOVA with the SPSS package (IBM SPSS Statistics, version 23, IBM Corp., Armonk, NY) statistical software for Mac OS.

Results and discussion

According to our investigation, there are differences in the total fatty acid content among the three types of goats (Table 2). The percentage of saturated, monounsaturated, total unsaturated, omega-3, omega-9, DHA, EPA and AA fatty acids in Boerawa goats is significantly different ($p < 0.01$) compared with Etawa and Kacang goats. However, the content of PUFA in Boerawa goats is not different from Etawa goats, but it is significantly different from Kacang goats ($p < 0.05$). The total contents of SFA, MUFA, PUFA, omega-6, omega-9, EPA, and AA in Etawa and Kacang goats are almost the same amounts. However, the omega-3 and DHA levels in Etawa goats tend to have a higher percentage than in Kacang goats.

Based on the analysis, the SFA content in Boerawa goats was lower than in Etawa and Kacang goats (60.6% vs. 68.9% and 70.8%). However, the content of MUFA in Boerawa goats was higher than in Etawa and Kacang goats (33.6% vs. 26.0% and 26.4%), as well as PUFA content in Boerawa goats was higher than in Kacang goats (5.8% vs. 2.8%). The content of omega-9 in Boerawa goats was higher than in the two other types of goats (32.1% vs. 24.8% and 24.4%). Moreover, the data show that the quality of suitable fatty acids (MUFA and PUFA) from Boerawa goats tends to be better than for the remaining types of local goats.

The percentage of SFA and total unsaturated fatty acids (MUFA and PUFA) in the three types of goats is almost the same as those reported by Lock et al. (2004), which explains that the SFA content in goat milk varies between 70 and 75%, MUFA level is between 20 and 25%, and PUFA level is about 5%.

Table 2. Means of total fatty acids content in milk from the different breeds of goats

Total Fatty Acids (FA)	FA content in the goat milk (%)			p value		
	Boerawa	Etawa	Kacang	Boerawa vs Etawa	Boerawa vs Kacang	Etawa vs Kacang
Saturated	60.6^{a}	68.9^{b}	70.8^{b}	<0.0001	<0.0001	0.19
Monounsaturated	33.6^{a}	26.0^{b}	26.4^{b}	<0.0001	<0.0001	0.24
Polyunsaturated	5.81^{a}	5.07^{ab}	2.83^{b}	0.69	<0.04	0.15
Total Unsaturated	39.4^{a}	31.1^{b}	29.2^{b}	<0.0001	<0.0001	0.19
Omega-3	0.32^{a}	0.39^{b}	0.15^{c}	<0.01	<0.0001	<0.0001
Omega-6	5.43	4.65	2.68	0.67	0.06	0.22
Omega-9	32.1^{a}	24.8^{b}	24.4^{b}	<0.0001	<0.0001	0.17
DHA	0.04^{a}	0.13^{b}	0.02c	<0.0001	<0.05	<0.0001
EPA	0.04^{a}	0.12^{b}	0.03^{a}	<0.0001	0.52	<0.0001
AA	0.70^{a}	0.29^{b}	0.27^{b}	<0.0001	<0.0001	0.61

[abc] Means in the same row with different superscripts differ at $p < 0.05$

Based on the data in Table 3, it shows that butyric (C4:0), caproic (C6:0), caprylic (C8:0), capric (C10:0), lauric (C12:0), tridecanoic (C13:0), and myristic (C14:0) contents in Boerawa goats were lower than in Kacang goats. Similarly, the contents of capric (C10:0), tridecanoic (C13:0), palmitic (C16:0), stearic (C18:0), heneicosanoic (C21:0), behenic (C22:0), and lignoceric (C24:0) in Etawa goats were higher than in Boerawa goats. However, there was no significant difference in butyric (C4:0), caproic (C6:0), caprylic (C8:0), and lauric (C12:0) content between Boerawa goats and Etawa goats. The content of undecanoic (C11:0) and tricosanoic (C23:0) also showed there were no differences among the three types of goats.

The difference in the composition of feed and the type of forage given to livestock can interfere with the balance of milk fatty acids (Kalac and Samkova, 2010). However, Tsiplakou et al. (2006) reported that breed properties influence the sheep's milk fatty acids composition even though the livestock were kept and given the same feed formulation.

Table 3. Means of saturated fatty acids (SFAs) content in milk from the different breeds of goats

Saturated Fatty Acids (SFAs)	FA content in the goat milk (%)			p value		
	Boerawa	Etawa	Kacang	Boerawa vs Etawa	Boerawa vs Kacang	Etawa vs Kacang
C4:0 (Butyric)	0.89[a]	0.87[a]	1.31[b]	0.88	<0.0001	<0.0001
C6:0 (Caproic)	1.07[a]	1.16[a]	1.84[b]	0.42	<0.0001	<0.001
C8:0 (Caprylic)	1.14[a]	1.26[a]	2.15[b]	0.45	<0.0001	<0.001
C10:0 (Capric)	3.10[a]	4.05[b]	6.39[c]	<0.02	<0.0001	<0.001
C11:0 (Undecanoic)	0.04	0.03	0.04	0.52	0.92	0.43
C12:0 (Lauric)	3.01[a]	3.76[a]	8.31[b]	0.24	<0.0001	<0.0001
C13:0 (Tridecanoic)	0.04[a]	0.10[b]	0.20[c]	<0.0001	<0.0001	<0.0001
C14:0 (Myristic)	8.34[a]	8.33[a]	12.6[b]	1.00	<0.001	<0.002
C15:0 (Pentadecanoic)	0.37[a]	0.79[ab]	0.86[b]	0.07	<0.04	0.90
C16:0 (Palmitic)	27.6[a]	30.6[b]	25.0[c]	<0.003	<0.01	<0.0001
C17:0 (Margaric)	0.82[a]	0.57[b]	0.64[ab]	<0.03	0.08	0.67
C18:0 (Stearic)	13.0[a]	15.1[b]	10.4[c]	<0.004	<0.001	<0.0001
C20:0 (Arachidic)	0.34[a]	0.50[b]	0.29[c]	<0.0001	<0.002	<0.0001
C21:0 (Henecosanaoic)	0.63[a]	1.65[b]	0.63[a]	<0.01	1.00	<0.02
C22:0 (Behenic)	0.06[a]	0.10[b]	0.05[a]	<0.0001	0.46	<0.0001
C23:0 (Tricosanoic)	0.01	0.01	0.01	0.46	0.46	1.00
C24:0 (Lignoceric)	0.03[a]	0.05[b]	0.03[a]	<0.01	1.00	<0.01

[abc] *Means in the same row with different superscripts differ at p<0.05*

In this study, the highest percentages of SFA were C16:0, C18:0, and C14:0. The high rate of C16:0 in this study was similar to an experiment conducted by Vargas et al. (2014) but different from a survey conducted in Australia, which reported that C18:0 is the most abundant SFA found in goats (Thomas and Rowney, 1996). Furthermore, there is the possibility that these differences are caused by different feed. In this case, there is less control of livestock consuming the grass from the environment. Therefore, the high percentage of C18:0 is probably caused by biohydrogenation of alpha-linolenic acid (Chilliard and Lamberet, 2001).

Table 4. Means of monounsaturated fatty acids (MUFAs) content in milk from the different breeds of goats

Monounsaturated FA (MUFA)	FA content in the goat milk (%)			p value		
	Boerawa	Etawa	Kacang	Boerawa vs Etawa	Boerawa vs Kacang	Etawa vs Kacang
C14:1 (Myristoleic)	0.06[a]	0.06[a]	0.22[b]	0.75	<0.0001	<0.0001
C16:1 (Palmitoleic)	1.02[a]	0.85[b]	1.40[c]	<0.0001	<0.0001	<0.0001
C17:1 (Heptadecenoic)	0.32[a]	0.14[b]	0.29[a]	<0.001	0.35	<0.003
C18:1 ω-9 cis (c-oleic)	32.1[a]	24.8[b]	24.4[b]	<0.0001	<0.0001	0.20
C20:1 (Eicosenoic)	0.11[a]	0.17[b]	0.04[c]	<0.0001	<0.0001	<0.0001
C24:1 ω-9 (Nervonic)	0.02[a]	0.03[b]	0.01[a]	<0.04	0.92	0.09

[abc] *Means in the same row with different superscripts differ at p<0.05*

In general, the percentage of total MUFA fatty acids in Boerawa goats is higher than in Etawa and Kacang goats. C18:1 ω-9 cis is the biggest component of fatty acid which is also found abundantly in Boerawa goats compared with Etawa and Kacang goats (32.1% vs 24.8% and 24.4%). Chilliard et al. (2005) reported that oleic acid (omega-9) is the most common MUFA fatty acid ranging between 15 and 21%. The C18:1 fatty acid component is the most widely grouped MUFA fatty acid component. In the same way, we also found that MUFA as the most abundant component, varying between 24 and 32%.

Table 5. Means of polyunsaturated fatty acids (PUFAs) content in milk from different breeds of goats

Polyunsaturated FA (PUFA)	FA content in the goat milk (%)			p value		
	Boerawa	Etawa	Kacang	Boerawa vs Etawa	Boerawa vs Kacang	Etawa vs Kacang
C18:2 ω-6 (Linoleic)	4.62	4.28	2.32	0.91	0.08	0.20
C18:3 ω-3 (Alpha-Linolenic)	0.25^a	0.14^b	0.08^b	<0.03	<0.01	0.24
C18:3 ω-6 (Gamma Linolenic)	0.03^a	0.04^a	0.06^{ab}	0.56	<0.02	0.09
C20:2 (Eicosadienoic)	0.05^a	0.04^a	0.01^b	0.19	<0.002	<0.01
C20:3 ω-6 (Eicosatrienoic)	0.08	0.04	0.04	0.28	0.22	0.98
C20:4 ω-6 (Arachidonic)	0.70^a	0.30^b	0.27^b	<0.0001	<0.0001	0.61
C20:5 ω-3 (Eicosapentaenoic)	0.04^a	0.12^b	0.03^a	<0.0001	0.52	<0.0001
C22:6 ω-3 (Docosahexaenoic)	0.04^a	0.13^b	0.02^a	<0.0001	0.06	<0.0001

[abc] Means in the same row with different superscripts differ at $p<0.05$

The data in Table 5 showed that there is no significant difference of linoleic acid (C18:2 ω-6) and eicosatrienoic (C20:3 ω-6) content among the three types of goats. The contents of alpha-linolenic (C18:3 ω-3) and arachidonic acid (C20:4 ω-6) in Boerawa goats were higher than in Etawa and Kacang goats. The highest EPA content was found in the Etawa goat with a concentration of 0.12%. The EPA content in Etawa is higher than in Boerawa and Kacang goats. In general, the EPA content in goats' milk ranges from 0.10 to 0.25% (Kompan and Komprej, 2012).

The crossbreed goats have better fatty acid content, which proved that there is the presence of complementary breeds among those goats. The better quality of fatty acids in crossbred offspring was also reported by Salem et al. (2004). The F1 offspring between Damascus goats and Barky goats showed a better ratio of unsaturated/SFAs than their parental Damascus and Barky goats. The effect of breeds on fatty acid profiles was also reported by Mierlita et al. (2011) who demonstrated differences in the content of SFA and PUFA between Turcana sheep and Spanca breeds.

This study showed that the fatty acids in Boerawa goats were significantly different from Etawa and Kacang goats. This result suggests that different species have different fatty acid profiles. Finally, Boerawa goats' milk fat contains healthier fatty acids than both types of local goats used in this study.

Conclusions

- This study showed that the quality of Boerawa goats' milk fat has a healthier variety of fatty acids than Etawa and Kacang goats. The content of SFA in the fatty acid was low, and the MUFA and PUFA fatty acid contents were higher than in Etawa and Kacang goats.
- These results also support the use of local genetic resources through a crossing program to improve the genetic quality of goats, especially the quality of milk fatty acids.

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