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Comparison of Fatty Acid Compositions in Different Goat Breeds: A Study in Negeri Sembilan, Malaysia

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Abstract

The aim of this study is to determine the influence of goat breeds (Saanen, Jamnapari and Boer) on the biological quality of milk in Malaysia and to compare the chemical composition of SFAs, MUFAs and PUFAs concentration of milk across the three breeds. Nine milk samples were collected from three different breed of goats namely Saanen, Jamnapari and Boer. All samples were taken in triplicate and analysed for fatty acid composition of the milk using gas chromatography-mass spectrometry (GC-MS). According to the GC-MS results, 13 fatty acids were identified and expressed relatively in percentage of peak areas (%) and evaluated in three types of fatty acid groups, which are saturated fatty acid (SFA), monounsaturated fatty acid (MUFA), and polyunsaturated fatty acid (PUFA). The total of SFA varies from 57.48% to 66.10% and is the most abundant fatty acid group in each of the samples. In addition, the total of MUFA was also found ranging from 22.07% to 39.06%, while the total of PUFA is from 0% to 4.06%. 13-octadecenoic acid was detected as the highest concentration for each of the Saanen and Jamnapari breed samples,

and hexadecanoic acid for the Boer breed samples. These results have confirmed that each individual species have their own unique fatty acid composition that can contribute as part of a complete nutrition for the well-being of the ummah.

Keywords: *goat milk, nutrition, fatty acids, gas chromatography-mass spectrometry*

Introduction

The dairy industry is part of the economic backbone of the country's agricultural sector. Demand for milk is increasing while the country's milk production cannot meet the overall demand. Statistics show that milk had to be imported from overseas. In 2013, the country's milk production was 79.35 million litres while the total demand was 852.89 million litres, exceeding total production (Rosali, et al., 2014). The percentage of self-sufficiency for Malaysian milk production was 9.3% while the rest had to be imported from overseas.

Goat is one of the main sources of milk production in Malaysia and acts as a significant constituent in the livestock industry. One of the most important contributions of goat's milk in terms of milk quality is the content of essential fatty acids and fatty acids (FA) group. Generally, goat's milk contains about 4.1 g of total fat, which consists of 2.7 g saturated fatty acid (SFAs), 1.1 g of monounsaturated fatty acid (MUFAs) and 0.1 g of polyunsaturated fatty acid (PUFAs) per 100 g (Getaneh, et al., 2016).

Many factors can affect the FA composition of goat's milk fat, including feeding practices (Syd Jaafar, et al., 2018), health and breed (Park & Haenlein, 2010; Sung et al., 1999). Several studies have shown that the breed can have positive effects on the quality of milk fat either directly or through processing of product. For instance, Soryal et al. (2005) mentioned that fatty acid concentration of soft cheese during lactation produced by a mixed herd is good and suitable to supply milk for cheesemaking. Moreover, as reported by Brito et al. (2011), there is a positive correlation between genetic advantage and milk constituents. In addition, Antunac et al. (2001) emphasized that a significant effect on content of total solids, protein, lactose, minerals, calcium and phosphorus was discovered throughout an experiment that compared different breeds for milk production.

Dairy goat breeds that are fit for farming in Malaysia are Saanen (butterfat 3.9%, protein: 2.8%), Toggenburg (butterfat 3.2%, protein: 2.8%) and Alpine (butterfat 3.3%, protein: 2.8%). Meanwhile, suitable goat breeds that are reared for dual function (meat and milk production) are Jamnapari and Anglo-Nubian (Universiti Putra Malaysia, 2011). In general, hybrid goat breeds are often used in this country because pure breed goats thrive better in cold climate countries rather than tropical climate (Capote, 2014).

Based on the scientific evidence that clearly prove the effect of breed on milk components, this study outlined two main objectives. The aims of this study are to determine the influence of goat breeds (Saanen, Jamnapari and Boer) on the biological quality of milk in Malaysia and to compare the chemical composition of SFAs, MUFAs and PUFAs concentrations of milk across the Saanen, Jamnapari and Boer breeds. Furthermore, this study was carried out at a preliminary stage, of which the results will be used in comparing the milk composition of other mammals for further expansion by the researchers. Overall, results obtained from this study can also be used as reference by organizations involved in livestock management, thus improving the quality of milk production in the country.

Materials and Methods

Animals and Sampling

Milk samples from the Saanen, Jamnapari and Boer breeds were collected from Tok Seri Buak Agrofarm in Nilai, Negeri Sembilan. The farm used the same rations (dry weed, dry soy bean)

and the same milking time (morning). The samples were stored immediately at -20˚C prior to use.

Quantification Of Fatty Acid Composition

A milk sample of 0.5 mL were added with 10 mL of hexane and 1 mL of sodium methoxide (5.4 M) in methanol solution. The mixture was vortexed for 1 minute. The resulting hexane layer was used as sample solution for GC (Sun & Zhao, 2014). Analysis of FAME was performed on a GC-MS 5977B by Agilent equipped with pulsed split injector. Separation were achieved using HP-5MS UI column (30 m × 0.25 mm × 0.25 µm film thickness). Helium was used as the carrier gas at flow rates of 2.1 mL/min and a split ratio 5:1. The injector temperature was 250°C. The oven temperature was programmed at 50°C with a hold of 1 minute, then increased to 200°C at a rate of 25°C/min, then another increase to 230°C at a rate of 3°C /min and hold at final temperature for 23 minutes. Intovu MS software was used to control the operation of GCMS. MS spectra were obtained at range width m/z 46-500 u, transfer line temperature 250°C, source temperature 230°C, quadrupole temperature 150°C and solvent cut time 3 minutes. All determinations were carried out in triplicate.

Result and Discussion

The results of statistical data of SFAs, MUFAs, PUFAs groups and fatty acid composition of milk fat samples taken are presented in Tables 1, 2 and 3. SFAs content was higher than both MUFAs and PUFAs fatty acid groups. SFAs showed the greatest variation between breeds (Table 1), whereas the MUFAs fatty acid group showed the smallest variation.

In SFAs, hexadecanoic acid varied between 15.48% and 40.02%, and is the most important SFAs in each of the samples. Hexadecanoic acid and methyl stearate have the highest value in SFAs group. Hexadecanoic acid has the highest value of fatty acids in each Jamnapari and Boer samples.

Table 1. Saturated fatty acid compositions (%)

Fatty Acid	Saanen	Jamnapari	Boer
Hexanoic	0.51	nd	2.32
Octanoic	0.69	nd	3.02
Decanoic	2.85	1.43	8.49
Undecanoic	0.46	0.72	0.87
Tridecanoic	1.75	3.41	2.45
Tetradecanoaic	8.84	nd	nd
Hexadecanoic	15.48	27.98	40.02
Stearic	28.87	23.94	8.93

*nd = not detected

Tetradecanoic acid was only found in milk samples taken from the Saanen breed. This variation makes the Saanen breed's milk considered to induce an increase in plasma cholesterol. Tetradecanoic acid plays an important role in cell regulation, modify several proteins of both eukaryotic, and viral origin by acylation (Rioux & Legrand, 2001). It is widely used in the treatment against cancer (TabletWise, 2018).

Table 2. Monounsaturated fatty acid compositions (%)

Fatty acid	Saanen	Jamnapari	Boer
13-octadecenoic	39.06	31.96	24.07
9-hexadecenoic	nd	0.25	nd

*nd = not detected

Octanoic acid shows other differences in SFAs between the Saanen and Jamnapari breeds. Octanoic acid, which are known as caprylic acid is also beneficial for human health, especially to treat epilepsy, dysbiosis, malabsorption, chyluria, steatorrhea, hyperlipoproteinemia, intestinal resection, premature infant feeding, non-thriftiness of children, infant malnutrition, cystic fibrosis, coronary by-pass, gallstones and chylothorax, because of its action of lowering serum cholesterol, and inhibiting and limiting cholesterol deposition (McGuire & McGuire,

2000; Arnould & Soyeurt, 2009; Haenlein, 2003). It also has antibacterial, antiviral, and antifungal properties that can treat ringworm and fight off bacterial infections (Wong, 2018; WebMD, 2009).

In all milk samples in the present study, MUFAs was the lowest compound detected among all fatty acids group. 13-octadecenoic acid was the common fatty acid found in MUFAs of the three breeds (Table 2). 13-octadecenoic acid has the highest value of fatty acids in each of the Saanen and Jamnapari breeds. The highest value of 13-octadecenoic acid (39.06%) was present in Saanen. However, 9-hexedecenoic were only detected once with low value in all samples.

Hexanoic, octanoic and tetradecanoic acid (SFA) were not detected in Jamnapari due to the high concentration of monounsaturated fatty acid. 9-hexadecenoic acid was only detected in Jamnapari. This is because the presence of ω-9 desaturase (SCD), also known as stearoyl coenzyme-A desaturase is high in Jamnapari breed. It converts specific SFAs into corresponding monounsaturated and polyunsaturated FAs (Bauman et al. 1999; Reh et al. 2004; Thomson et al. 2003). Increase of SCD activity is able to increase unsaturated FAs compositions in milk thus improve quality of milk.

Table 3. Polyunsaturated fatty acid compositions (%)

Fatty acid	Saanen	Jamnapari	Boer
9,15-octadecadienoic	nd	2.28	nd
Octadecadienoaic	nd	1.78	nd

*nd = not detected

Examining PUFAs determined in all samples, both 9,15-octadecadienoic acid and octadecadienoaic acid are only found in milk samples taken from Jamnapari breeds (Table 3). The value of 9,15-octadecadienoic acid (2.28%) and octadecadienoate acid (1.78%) are the other fatty acids compound found in the different breeds of goat. These two fatty acids promote different effects towards human health.

Concentration of PUFAs, especially of ω-3 and CLA is affected by type of feeding or genetic variability (Arnould & Soyeurt, 2009). Feed control is an efficient way to increase PUFAs, but the effects are not stable. So, breed selection is important for nutritional improvement. Further comparative differences in content of FA need further study.

Conclusion

The study results confirmed that there are differences in milk composition between different goat breeds given the same rations in terms of SFAs, MUFAs and PUFAs concentrations. The differences in milk fatty acid concentrations between breeds are important for human health. Therefore, goat breeds should be taken into consideration and this study can act as reference that may be used by other organizations involved in livestock management, thus improving the quality of milk production in the country.

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