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## SHORT COMMUNICATION

# Proximate composition, short and medium-chain fatty acids of selected powdered goats milk

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### ABSTRACT

**Introduction:** Goats milk provides health benefits due to its unique fatty acid composition that comprises relatively high amounts of short- and medium-chain fatty acids, which make goats milk easy to digest. **Methods:** A total of 20 powdered goats milk samples were selected based on ease of availability in shops in Kubang Kerian, Kelantan. Proximate composition and fatty acids, specifically C6:0, C8:0 and C10:0 were determined using AOAC methods (2000), and gas-chromatography, respectively. Results were compared with commercial pure goats milk (CBM®). **Results:** Wide variations in the proximate composition and fatty acid contents were found among the samples when compared with the CBM® sample. The mean range values for energy were 368 to 498 kcal/100 g, moisture: 2.46 to 4.28 g/100 g, ash: 2.04 to 6.61 g/100 g, protein: 2.80 to 26.24 g/100 g, fat: 1.68 to 25.90 g/100 g and carbohydrates: 44.81 to 87.64 g/100 g. The total short and medium-chain fatty acids contents ranged from 3.22% to 12.97%. **Conclusion:** There is a need for standardisation of the proximate composition and fatty acids contents of goats milk available in Malaysia.

**Keywords:** Goats milk, proximate composition, medium-chain fatty acids (MCFA)

## INTRODUCTION

Although there is no official statistical record of the current production of goats milk in Malaysia (Shanmugavelu & Quaza Nizamuddin, 2013), goats milk consumption is perceived to have become popular among Muslim consumers, because of the claim that it is a kind of prophetic food with health benefits (Rani *et al.,* 2016).

While goats milk is mainly sold in fresh liquid form in the market, it is also available in powdered form. The nutritional quality and taste of goats milk is usually compared to cows milk. Owing to its relatively high amount of short- and medium- chain fatty acids content, goats milk facilitates nutrient absorption, especially in improving fat absorption (Zenebe *et al.,* 2014; Alferez *et al.*, 2001).

The most reported health benefits of goat's milk are its advantages in improving weight and undernutrition.

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This was reported by a research conducted in Madagascar amongst thirty hospitalised malnourished children (1 to 5 years old) which succeeded in increasing their body weight by 9% (Razafindrakoto *et al.,* 1994). Meanwhile, a study in New Zealand with seventy-two new born infants showed that infants who were fed with goat's milk gained an average of 309 gram more weight than before over the 168-day of study period (Grant *et al.,* 2005).

There are limited studies on the proximate and fatty acids analyses of powdered goats milk available in Malaysia. This study aimed to determine the proximate and fatty acids contents of selected powdered goats milk, with focus on short- and medium- chain fatty acids contents.

## MATERIALS AND METHODS

### Sampling

A total of twenty powdered goats milk samples of different brands were bought from various supermarkets, small sundry shops and through online shopping websites. The supermarkets and small sundry shops were located in Kubang Kerian, Kelantan. The samples' prices ranged from RM7 to RM11 per 100 g. The inclusion criteria include goats milk that are suitable for four years old and above, while flavoured goat' milk was excluded. As a reference, a pure full cream goats milk sample (powdered form) was obtained from The Netherlands (CBM®). Most goats milk in the Malaysian market generally use CBM® as their base ingredient.

### Proximate analysis

The samples were analysed individually in triplicate. Proximate analysis was undertaken based on AOAC (2000). Moisture content was obtained using air-oven dried method (105°C). Ash was determined by incineration in a muffle furnace at 550°C. Protein content was determined by micro-Kjeldahl analyser, i.e. Kjeltec Auto 2300 Analyzer, Denmark. The composition of fat in powdered goats milk was determined by Modified Mojonnier method. Carbohydrate was determined by subtracting from 100, the sum of moisture, ash, protein and fat percentage. Total energy was calculated as: Energy = (protein x 4) + (fat x 9) + (carbohydrate x 4).

### Short and medium-chain fatty acids analysis

The fatty acids profile in powdered goat's milk was determined by Gas Chromatography (GC) method (Christie, 1989). Data obtained from chromatogram was analysed. Peak identification was based on retention time of reference standards based on peak area percentages (Supelco® 37, Bellefonte, PA).

### Statistical analysis

The results were analysed by applying descriptive statistical analysis using mean value, standard deviation (SD), maximum and minimum values (IBM SPSS Statistics Version 22). ANOVA analysis was carried out to determine the differences and to compare using the Duncan test with 5% of significance.

## RESULTS AND DISCUSSION

Out of twenty analysed samples, only nine contain pure goat's milk (based on the ingredient's label). This indicates that most of the samples analysed in this study were not pure goat's milk, but contained a mixture of other ingredients, such as non-dairy creamer and extracts of raisin, honey, pomegranate, and other miscellaneous ingredients.

### Proximate analysis

The proximate analysis of the powdered goats milk compared with the reference

**Table 1.** Proximate analysis of 20 samples of powdered goat's milk and reference value (g/100 g)

| *Sample* | *Moisture* | *Ash* | *Protein* | *Fat* | *Carbohydrate* | *Energy (kcal/100 g)* |
|---|---|---|---|---|---|---|
| | *Mean*±SD | | | | | |
| G1 | $4.11^{h}\pm0.02$ | $2.45^{d}\pm0.06$ | $2.92^{a,b}\pm0.01$ | $16.38^{j}\pm0.24$ | $74.14^{i}\pm0.28$ | $456^{k}\pm1$ |
| G2 | $4.13^{h}\pm0.06$ | $2.85^{g}\pm0.01$ | $9.33^{h}\pm0.04$ | $9.33^{c}\pm1.12$ | $74.36^{i}\pm1.10$ | $419^{c}\pm6$ |
| G3† | $3.96^{g}\pm0.06$ | $2.44^{c,d}\pm0.01$ | $3.07^{b}\pm0.02$ | $14.50^{h,i}\pm0.18$ | $76.04^{j}\pm0.26$ | $447^{i}\pm1$ |
| G4† | $3.91^{g}\pm0.01$ | $2.45^{d}\pm0.01$ | $3.06^{b}\pm0.01$ | $11.66^{f,g}\pm0.13$ | $78.92^{l,m}\pm0.14$ | $433^{f,g}\pm1$ |
| G5† | $4.28^{i}\pm0.01$ | $2.50^{e}\pm0.01$ | $3.02^{a,b}\pm0.02$ | $11.65^{f,g}\pm0.02$ | $78.55^{k,l}\pm0.03$ | $431^{f,g}\pm0$ |
| G6 | $3.33^{e}\pm0.01$ | $2.04^{a}\pm0.00$ | $2.80^{a}\pm0.03$ | $4.19^{b}\pm0.40$ | $87.64^{q}\pm0.44$ | $399^{b}\pm2$ |
| G7 | $3.12^{d}\pm0.08$ | $3.69^{i}\pm0.00$ | $8.34^{f}\pm0.00$ | $13.84^{h}\pm0.31$ | $71.01^{h}\pm0.23$ | $442^{h}\pm2$ |
| G8† | $3.31^{e}\pm0.06$ | $3.69^{i}\pm0.01$ | $15.66^{j}\pm0.02$ | $16.73^{j,k}\pm0.11$ | $60.62^{e}\pm0.08$ | $456^{k}\pm1$ |
| G9 | $2.68^{b}\pm0.01$ | $3.28^{h}\pm0.02$ | $5.78^{e}\pm0.07$ | $10.07^{d}\pm0.11$ | $78.19^{k}\pm0.14$ | $427^{d,e}\pm1$ |
| G10 | $2.46^{a}\pm0.00$ | $5.92^{k}\pm0.00$ | $21.37^{k}\pm0.10$ | $14.90^{i}\pm0.63$ | $55.36^{d}\pm0.52$ | $441^{h}\pm3$ |
| G11 | $3.51^{f}\pm0.05$ | $6.61^{n}\pm0.07$ | $26.24^{n}\pm0.38$ | $1.68^{a}\pm0.13$ | $61.96^{f}\pm0.23$ | $368^{a}\pm1$ |
| G12† | $3.31^{e}\pm0.06$ | $2.41^{c,d}\pm0.02$ | $3.16^{b}\pm0.00$ | $10.46^{d,e}\pm0.03$ | $80.66^{n}\pm0.05$ | $429^{e,f}\pm1$ |
| G13† | $3.49^{f}\pm0.01$ | $2.43^{c,d}\pm0.00$ | $3.16^{b}\pm0.01$ | $11.45^{f}\pm0.13$ | $79.46^{m}\pm0.11$ | $434^{g}\pm1$ |
| G14† | $3.01^{c}\pm0.00$ | $2.35^{b}\pm0.02$ | $3.10^{b}\pm0.02$ | $10.22^{d}\pm0.46$ | $81.32^{o}\pm0.40$ | $430^{e,f}\pm3$ |
| G15 | $2.75^{b}\pm0.15$ | $2.40^{b,c,d}\pm0.01$ | $3.51^{c}\pm0.27$ | $12.31^{g}\pm0.03$ | $79.04^{l,m}\pm0.14$ | $441^{h}\pm1$ |
| G16† | $3.13^{d}\pm0.04$ | $2.39^{b,c}\pm0.07$ | $3.13^{b}\pm0.02$ | $9.18^{c}\pm0.03$ | $82.17^{p}\pm0.02$ | $424^{d}\pm0$ |
| G17† | $2.77^{b}\pm0.02$ | $6.19^{l,m}\pm0.00$ | $24.59^{l}\pm0.12$ | $21.65^{m}\pm0.65$ | $44.81^{a}\pm0.51$ | $472^{l}\pm4$ |
| G18 | $3.39^{e}\pm0.01$ | $4.69^{j}\pm0.01$ | $12.57^{i}\pm0.15$ | $25.90^{n}\pm0.33$ | $53.46^{c}\pm0.20$ | $498^{m}\pm2$ |
| G19 | $3.92^{g}\pm0.03$ | $2.74^{f}\pm0.06$ | $4.74^{d}\pm0.06$ | $19.35^{l}\pm0.55$ | $69.25^{g}\pm0.52$ | $470^{l}\pm3$ |
| G20 | $3.06^{c,d}\pm0.01$ | $6.16^{l}\pm0.04$ | $9.06^{g}\pm0.11$ | $10.97^{e,f}\pm0.17$ | $70.74^{h}\pm0.30$ | $418^{c}\pm1$ |
| Reference | $2.43^{a}\pm0.03$ | $6.23^{m}\pm0.00$ | $25.18^{m}\pm0.27$ | $17.21^{k}\pm0.46$ | $48.96^{b}\pm0.16$ | $451^{j}\pm3$ |

†Samples that based on ingredient list were pure goat's milk and not added with other ingredients.
$^{a,b,c,d,e,f,g,h,i,j,k,l,m,n,o,p,q}$Different alphabets in the same column denote significant difference according to Duncan's test (5%).

are shown in Table 1. The reference sample composition was found to be consistent with the findings of Reddy *et al.,* (2014), Batiston *et al.,* (2012), and Park (2000) for energy, ash and protein contents. The proximate analysis of the commercial samples of powdered goats milk showed that Sample G5 provided the highest moisture content. (4.28 g/100 g), while Sample G10 had the lowest (2.46 g/100 g), compared to the reference value (2.43 g/100 g).

The ash content of powdered goat's milk samples ranged between 2.04 g/100 g to 6.61 g/100 g and only two samples of powdered goat's milk; Sample G17 and Sample G20 were comparable to the value of the reference sample (6.23 g/100 g).

Overall, wide variations were found for energy, protein and fat contents among the studied samples. The energy value of the powdered goat's milk varied from 368 kcal/100 g to 498 kcal/100 g. Most of the samples showed statistically significant difference when compared against the reference sample (451 kcal/100 g). In terms of the protein content, Sample G11 had the highest value (26.24 g/100 g), while Sample G6 had the lowest (2.80 g/100 g), compared with the reference protein value of 25.18 g/100 g. Meanwhile, the highest and the lowest fat contents were 25.90 g/100 g (Sample G18) and 1.68 g/100 g (Sample G11), respectively. According to the label of the sample which contained the lowest fat content, its first ingredient was listed as skim milk, and this may explain the low amount of its total fat content. The carbohydrate content of powdered goats milk was wide, ranging between 44.81 g/100 g to 87.64 g/100 g. Only Sample G17 was quite close to that of the reference sample. The high content of carbohydrate in the analysed samples may be attributed to the added ingredients, such as dates, raisin, and honey, such as shown for Sample G6 which had the highest carbohydrate content (87.64%) and it had added honey and dates.

**Fatty acids analysis**

Table 2 shows the short and medium-chain fatty acids contents in commercial powdered goat's milk samples and the reference sample. Haenlein (2004) reported that goats milk was higher in C6 to C10 than cows milk. This study showed that the total medium-chain fatty acids (MCFA) ranged between 3.22% (Sample G3) to 12.97% (Sample G17), compared to that in the reference sample (11.66%). The result also showed that 12 samples contained C6:0 to C10, while eight samples had only C8:0 and C10:0. Based on ANOVA, there was a significant difference in the total fatty acids and C10:0 for all samples compared to the reference sample. This may be due to the added ingredients in the studied goats milk, especially those added with palm oil or non-dairy creamer.

The richness of short and medium-chain fatty acids in goats milk helps to facilitate improvement of nutrient absorption and energy production in the human body (Zenebe *et al.,* 2014). Apart from that, these fatty acids in goats milk have been recognised as unique lipid with health benefits claimed for treating malabsorption syndromes, chyluria, steatorrhea, hyperlipoproteinnemia, and for premature infant feeding (Vaquil & Rathee, 2017).

According to Salari *et al.,* (2016), quality of fatty acid profile can be affected by season. Some fatty acids were found to be significantly reduced during summer. Norris *et al.,* (2011) also found that the fat content was lower in Saanen breed as compared to the other breeds, such as Toggenburg and British Alpine even though it produces more milk. In this study, most

**Table 2.** C6:0, C8:0, C10:0 and total MCFA of present study and reference value (%)

| Sample | *C6:0* | *C8:0* | *C10:0* | *Total MCFA (%)* |
|---|---|---|---|---|
| | *Mean±SD* | | | |
| G1 | 0.76$^{d}$±0.06 | 2.18$^{c}$±0.05 | 2.83$^{c}$±0.08 | 5.78$^{c}$±0.20 |
| G2 | 1.37$^{f}$±1.57 | 2.69$^{d,e}$±0.25 | 5.66$^{g}$±0.46 | 9.72$^{h}$±0.86 |
| G3 | 0.07$^{a,b}$±0.00 | 1.47$^{a}$±0.02 | 1.68$^{a}$±0.02 | 3.22$^{a}$±0.04 |
| G4 | 1.52$^{g}$±0.09 | 2.87$^{e}$±0.06 | 5.76$^{g}$±0.10 | 10.14$^{h}$±0.25 |
| G5 | 0.15$^{b}$±0.00 | 1.28$^{a}$±0.02 | 1.96$^{a}$±0.00 | 3.39$^{a}$±0.01 |
| G6 | 0.51$^{c}$±0.02 | 2.10$^{b,c}$±0.09 | 3.79$^{d}$±0.08 | 6.40$^{d}$±0.18 |
| G7 | 1.01$^{e}$±0.24 | 2.04$^{b,c}$±0.17 | 3.59$^{d}$±0.16 | 6.64$^{d}$±0.56 |
| G8 | - | 3.39$^{f}$±0.04 | 4.53$^{e}$±0.06 | 7.92$^{e,f}$±0.10 |
| G9 | 0.01$^{a}$±0.01 | 2.75$^{e}$±0.34 | 2.29$^{b}$±0.14 | 5.05$^{b}$±0.48 |
| G10 | 1.71$^{h}$±1.63 | 1.44$^{a}$±0.11 | 5.56$^{g}$±0.24 | 8.71$^{g}$±0.51 |
| G11 | 0.02$^{a,b}$±0.00 | 1.91$^{b}$±0.02 | 6.52$^{h}$±0.09 | 8.45$^{f,g}$±0.11 |
| G12 | - | 3.89$^{h}$±0.13 | 3.56$^{d}$±0.07 | 7.45$^{e}$±0.21 |
| G13 | - | 3.87$^{h}$±0.01 | 3.62$^{d}$±0.03 | 7.49$^{e}$±0.04 |
| G14 | - | 3.86$^{h}$±0.00 | 3.62$^{d}$±0.04 | 7.47$^{e}$±0.04 |
| G15 | - | 3.83$^{h}$±0.01 | 3.55$^{d}$±0.01 | 7.38$^{e}$±0.02 |
| G16 | - | 4.18$^{i}$±0.01 | 3.71$^{d}$±0.06 | 7.89$^{e,f}$±0.08 |
| G17 | 0.02$^{a,b}$±0.00 | 2.88$^{e}$±0.13 | 10.07$^{k}$±0.45 | 12.97$^{j}$±0.58 |
| G18 | - | 3.44$^{f,g}$±0.09 | 5.22$^{f}$±0.10 | 8.67$^{g}$±0.02 |
| G19 | - | 5.27$^{j}$±0.03 | 4.63$^{e}$±0.08 | 9.90$^{h}$±0.06 |
| G20 | 1.64$^{h}$±0.06 | 3.61$^{g}$±0.08 | 7.20$^{i}$±0.14 | 12.45$^{j}$±0.28 |
| Reference | 0.01$^{a,b}$±0.00 | 2.54$^{d}$±0.03 | 9.10$^{j}$±0.08 | 11.66$^{i}$±0.11 |

Medium-Chain Fatty Acids (MCFA) [C6:0 to C10:0].

[a,b,c,d,e,f,g,h,i,j,k]Different alphabets in the same column denote significant difference according to Duncan's test (5%).

of the commercial powdered goats milk samples was used CBM® as a base with different percentages and the breed used by CBM® was known as Saanen breed. Thus, variation in the fatty acid does contribute to the difference in short and medium-chain fatty acids content. The low short and medium-chain fatty acids content in the present study could also be due to the low proportion of goat's milk incorporated in the commercial goats milk powder samples. As stated earlier, some of the goat's milk samples in this study were not purely goats milk but consisted of other ingredients. Furthermore, the fatty acid profile of this study do not originated from goats milk only, but also from other added ingredients. Thus, a large difference in fatty acid contents as compared to other studies would be expected.

## CONCLUSION

Considering the increasing importance of goat's milk to human nutrition especially for its fatty acids believed to aid in digestion, these findings indicate the need to standardise the proximate and fatty acids contents of goats milk in Malaysia.

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**Authors' contributions**

Juliana S carried out the experiment, analysed the data and wrote the manuscript with the support from all authors, Marina AM help with the data analysis, Shariza AR & Sakinah H help supervise the project and writing process.

**Conflict of interest**

The authors declare that they have no conflicting interests either financial or non-financial.

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