Effect of feeding management and seasonal variation on fatty acid composition of Mexican soft raw goats’ milk cheese

Claudia Delgadillo Puga, Mario Cuchillo Hilario, Fernando Pérez-Gíl Romo

Instituto Nacional de Ciencias Médicas y Nutrición Salvador Zubiran, México.

Corresponding author: Claudia Delgadillo Puga. Departamento de Nutrición Animal, INCMNSZ. Vasco de Quiroga No.15 Tlalpan México C.P. 14000 – Tel. +01 54870900 Ext. 2820. - Email: dpclau@quetzal.innsz.mx.

ABSTRACT – A study was conducted to evaluate the effect of feeding management and seasonal variation (summer and winter 2007) on fatty acid composition of Mexican soft raw goats’ milk cheese. Four groups were formed. During the summer, group A grazed on a natural semiarid rangeland. group B was kept in confinement, fed with concentrate grains and lucerne hay. Through the winter group C grazed on the same rangeland with supplementation and group D was fed as the group B. Thereafter, four kinds of cheeses were manufactured from milk of each animal group: grazed-summer (GS), indoor-summer (IS), grazed-winter (GW) and indoor-winter (IW). Results of this study indicated that fat content in cheese was affected by season. Moreover, during the summer period, pasture-based regime increased monounsaturated and polyunsaturated fatty acid concentrations; however, winter season could diminish the cheese desirable fatty acid profile.

Key words: Goat milk, Cheese, Grazing, FAME.

Introduction – Although traditionally in Mexico goat milk has been processed as a candy, lately a steady growing amount of goat milk has been used for cheese production (Galina et al., 2007). Regardless of the fact that many questions remain unclear concerning about the optimal goat production system, plant biodiversity of semiarid resources have been conventionally use as a part of goat diets (Cuchillo et al., 2009; Puga et al., 2009). However, it is not well known whether this pastoral system could affect cheese composition in different seasons (Morand-Fehr et al., 2007). Therefore, the present study compares the effect of two feeding systems (grazing and an indoor full feeding system), on the fatty acid composition of artisan goat milk cheese in summer and winter.

Material and methods - The study was conducted in Querétaro, Mexico, during 2007. Four groups (A, B, C and D) were formed, each with 20 French Alpine goats. During the summer, group A after milking grazed 8 hours/d on 14ha on a semiarid rangeland, with overnight confinement. group B was kept indoor, fed daily with 1kg of concentrate grains (18% of CP and 2.5 Mcal/kg) and 1.5kg of lucerne hay. Through the winter group C after milking grazed 8 hours/d on the same rangeland as group A, supplemented with 200g of concentrate grains in the morning and 300g of lucerne hay in the evening. group D was managed as the group B. Five times in each season, 40kg of daily milk raw were collected from each group. Therefore four kinds of cheeses were manufactured: grazed-summer (GS), indoor-summer (IS), grazed-winter (GW) and indoor-winter (IW), obtaining five batches for each kind of cheese, with a total of 20 samples. Moisture (oven-drying at 60°C) and ash (burning at 550°C in an electric furnace) were determined using standard methods (AOAC, 2003). Nitrogen was measured using the Kjeldahl method (AOAC, 2003). Gross energy was determined using the calorimetric Parr bomb (Parr Instrument Company, Illinois. USA). Total lipids were determined according to official method 696.33 (AOAC, 2003). Methyl-esters were carried out according to official method using gas...
chromatographic equip. The results were analyzed with a Completely Random Variance Analysis in a 2x2 factorial arrangement, with two year seasons (summer and winter) and two feeding systems (grazing and indoor). Comparison of the means with a significant difference (P<0.05) were determinate by Tukey's test (Steel and Torrie, 1985). All data were also analyzed using ANOVA for Statistical Analysis System program (SAS, 1996).

**Results and conclusions** – Gross composition values were similar among soft cheeses; however fat content was higher (P<0.05) in summer than winter cheeses (Table 1).

Morand-Fehr et al. (2007), explained the influence of feeding system on goat milk, and indicated that the cheese quality depends closely on the composition of milk, and that a higher proportion of fat content characterizes milk from ruminants fed pasture when compared to animal under indoor management system.

Regardless this fact, the seasonal changes in milk fat content observed in this trial were probably related to the dilution effect due to the greater amount of milk produced during the winter and the lower milk yield recorded in summer season (Galina et al., 2007).

Results of saturated fatty acids values (data not presented) were higher in GS and GW compared to IS and IW. Sanz Sampelayo et al. (2007) discussed deeper the significance of these fatty acids and the possible implications in chronic diseases. Table 2 shows that concentration of cis-9-Octadecenoic acid (oleic) C18:1, known as hypocholesterolemic fatty acid, was significantly higher (P<0.001) in GS compared with GW, IS and IW. On the whole, summer cheeses showed a higher monounsaturated fatty acid concentration (P<0.001). Polyunsaturated fatty acids (C18:2 to C22:6) were summarized in Table 3. During summer period cheese fatty acids coming from pasture-based feeding were higher compared with indoor managing. Sanz Sampelayo et al. (2007) mentioned that when fodders are the major source of feeding, greater quantities of unsaturated fatty acids are present in milk products, which

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**Table 1.** Gross composition of soft goat’s milk cheeses (mean ±se, % DM).

|        | GS   | IS   | GW   | IW   |
|--------|------|------|------|------|
| Protein| 34.18±2.37 | 36.67±2.14 | 36.62±2.12 | 36.66±0.98 |
| Ash    | 3.76±0.16  | 4.34±0.41  | 4.03±1.16  | 5.59±2.80  |
| Fat    | 46.4±3.01a | 45.74±0.75a | 31.70±5.09b | 30.72±3.25b * |
| Fat:protein ratio | 1.98±0.13a | 1.94±0.08b | 1.36±0.19b | 1.33±0.13b * |
| Energy (MJ/Kg) | 23.42±1.00 | 23.60±0.89 | 23.16±0.57 | 23.04±0.94 |

*ab=Different letters between columns indicate significant differences; *=P<0.05.

**Table 2.** Monounsaturated fatty acid methyl esters profile of soft goats’ milk cheeses (mean ±se, % of total lipids).

|        | GS   | IS   | GW   | IW   |
|--------|------|------|------|------|
| C15:1  | 0.321±0.06a | 0.288±0.04b | 0.099±0.06a | 0.118±0.05c ** |
| C16:1 Palmitoleic | 0.832±0.01a | 0.859±0.05a | 0.218±0.01b | 0.244±0.02b ** |
| C17:1  | 0.545±0.08a | 0.371±0.02b | 0.124±0.05c | 0.105±0.05d ** |
| C18:1 Oleic | 27.48±1.53a | 23.12±1.24b | 7.13±0.51c | 7.67±0.52c ** |
| C22:1 Erucic | 0.014±0.005a | 0.102±0.067a | 0.009±0.005b | 0.009±0.008b ** |
| C24:1 Nervonic | 0.061±0.0009a | 0.021±0.018b | 0.003±0.001c | 0.004±0.003c ** |

*abc=Different letters between columns indicate significant differences; **=P<0.001.
could clarify why products from grass based diets contain more PUFAs than install feeding. Grazing during winter, with lack of vegetation and green herbage, could lead to a lesser content of desirable fatty acids on goat cheese (Cuchillo et al., 2009; Galina et al., 2007; Morand-Fehr et al., 2007).

In conclusion, results of this study indicated that fat content in cheese was affected by season. Moreover, during the summer period, pasture-based regime increased monounsaturated and polyunsaturated fatty acid concentrations; however, winter season could diminish the cheese desirable fatty acid profile.

Table 3. Polyunsaturated fatty acid methyl esters profile of soft goats’ milk cheeses (mean ±se, % of total lipids).

| 18:2 Linoleic (LA) | 18:2 Linolelaidic | 18:3 Alpha-linolenic (ALA) | 18:3 Gama-linolenic | 20:2 | 20:3 homo-γ-linolenic | 20:3 Timnodonic (EPA) | 22:2 | 22:6 Cervonic (DHA) |
|-------------------|-------------------|-----------------------------|-------------------|------|-------------------|----------------------|------|-------------------|
| GS                | IS                | GW                          | IW                |      |                   |                      |      |                   |
| 2.83±0.04a        | 2.67±0.21a        | 0.96±0.06b                  | 0.97±0.07b        | **   |
| 0.752±0.08a       | 0.636±0.05b       | 0.102±0.08c                 | 0.196±0.01d       | **   |
| 0.745±0.02b       | 1.13±0.01a        | 0.256±0.014c                | 0.247±0.01c       | **   |
| 0.024±0.08b       | 0.022±0.02b       | 0.056±0.02a                 | 0.055±0.05a       | **   |
| 0.031±0.01ab      | 0.042±0.01a       | 0.023±0.01b                 | 0.033±0.02ab      | *    |
| 0.02±0.05b        | 0.02±0.04a        | 0.01±0.0008b                | 0.01±0.001b       | *    |
| 0.112±0.006b      | 0.089±0.01b       | 0.039±0.002c                | 0.042±0.002c      | **   |
| 0.232±0.01a       | 0.170±0.007b      | 0.087±0.002c                | 0.099±0.05c       | **   |
| 0.064±0.002a      | 0.040±0.006b      | 0.024±0.001c                | 0.029±0.002c      | **   |
| 0.045±0.003b      | 0.019±0.002c      | 0.010±0.0001d               | 0.024±0.001b      | **   |
| 0.035±0.01a       | 0.012±0.01c       | 0.018±0.01bc                | 0.023±0.02b       | **   |

a,b,c=Different letters between columns indicate significant differences; *=P<0.05; **=P<0.001.

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