

Evaluation of goat milk produced in the Highlands of Cameroon for cheese making

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Key words

Goat - Milk - Cheese making - Central Africa - Cameroon.

Summary

Fresh goat milk produced from a flock of dairy goats at the Mankon Station of the Institute of Animal and Veterinary Research (IRZV) Cameroon was evaluated for its suitability for cheese making. The goats involved were the Toggenberg, Saanen and Nubian breeds. Chemical analysis revealed that milk produced in the rainy season (April to October) had a fat content between 27 to 44 g/l, a protein content between 29 to 39 g/l and a dry matter content between 109 to 127 g/l. Milk was used successfully to manufacture fresh white cheese, feta-type cheese and pressed-type cheese. The mean fat contents were 9.8, 19.0 and 24.6% w/w for fresh white cheese, feta-type and pressed-type cheeses, respectively. Similarly, cheese total dry matter were 42.2% w/w for fresh white cheese, 50.0% w/w for feta and 56.8% w/w for pressed-type cheese.

■ INTRODUCTION

Goat milk contributes considerably to human nutrition as a good source of protein. Total goat milk production represents 1.6% of the global milk production in the world (8). In North Africa, goat milk plays a very important role as feeding ingredient in the diet of the population. Feta cheese from goat milk is quite popular and well appreciated. In sub-Saharan Africa, despite the presence of large flocks of goats, milk production from these animals remains very limited. In Cameroon, goats are kept solely for meat and cultural festivals. They are seldom milked. The Sahel dairy goats were recognized as a breed of dairy goats from the size of their udders in the Northern part of Cameroon.

In the early '80s, the Hieber Project International (HPI) introduced some high producing dairy goats in the Mid- and High-Altitude Zone of Cameroon. The exotic breeds comprising Toggenberg, Saanen and Nubian goats were reared at the Mankon Station of the Institute of Animal and Veterinary Research (IRZV). The aim was to improve the potential and productivity of the local dwarf goat. Consequently, fresh goat milk became available to this population who still had to become familiar with goat milk. The need to transform and preserve the milk became urgent and some technology for cheese making was introduced. This work is intended to evaluate the production of some cheese varieties from goat milk suitable to the climatic conditions of the Mid- and High-Altitude of Cameroon.

■ MATERIALS AND METHODS

Milk

Fresh morning milk from hand-milking was collected from a flock of mixed breeds of dairy goats comprising Toggenberg, Saanen and Nubian goats. Immediately after hand-milking, fresh milk from various breeds was mixed and analytical samples were taken in glass bottles and stored at 5°C. It was used the next day for analysis and cheese making at the Dairy Technology Laboratory in Bambui. Three samples were analyzed monthly.

The dairy flock was made of 40 Nubian, 30 Saanen and 30 Toggenberg goats. Five to 10 goats in each breed were milked at a time. Lactation length was 133 days for Nubians and 143 days for Toggenberg and Saanen with a daily milk production of 0.8 to 1.2 kg of milk per animal (14).

The goats were grazing freely on an improved pasture, containing *Brachiaria ruziziensis*, *Melinis minutiflora*, *Pennisetum purpureum*, *Desmodium intortum* and *Trypsacum laxum* (1).

The milking goats were given 250 g of feed supplement containing 40% w/w corn 43% w/w rice bran, 15% w/w cotton seed cake and 2.1% w/w dicalcium phosphate and salt. In the dry season, November to March, goats were given an extra 225 g supplement containing 97% w/w cotton seed cake, 3% w/w bone meal and salt (14).

Starter cultures

The cheese starter cultures used were supplied by New England Cheese Making Supplies Co. (USA). It contained mixed strains of *Lactococcus lactis* and *L. cremoris*. The lyophilized cultures were reactivated by the method of Cox and Lewis (3).

1. Irad, Bambui, PO Box 51, Bamenda, Cameroon

2. Irad Mankon, Cameroon

3. Irad, PO Box 1457, Yaounde, Cameroon

Rennet

Single strength calf rennet (New England Cheese Making Supplies Co.) was used. It was diluted with distilled water before addition to cheese milk.

Cheese making equipment

The equipment used was selected on the basis of its availability on the local market and at the farm level. Some basic kitchen tools comprised aluminum pots, a long knife, muslin cheese cloth, a gas burner, a thermometer, some cheese molds and a large supply of potable water. A standard wheeler press for 1 to 1.5 kg of cheese was also available.

Experimental procedures

Bulk milk for analysis and cheese making was collected thrice a month during the rainy season (April-October) of 1987. This period coincided with high milk production. Three types of cheese were manufactured from the collected milk: feta-type, fresh white cheese similar to saint-maure and a pressed-type cheese similar to queso de malaga. They were selected based on their relatively easy manufacturing at the farm level (feta and fresh cheeses) and the demand of cheese at the local retail outlet (pressed cheese). A total of 16 cheeses were manufactured: 4 fresh cheeses, 7 feta-type and 5 pressed-type cheeses. Ten liters of cheese milk were used for each type of cheese.

Chemical analyses

Prior to analyses, milk samples were warmed to 40°C on a Bunsen burner, and cooled to 20°C in a water bath. The bottles were shaken to ensure proper mixing. Cheese samples were collected for analysis at the end of the maturation period. Fat contents of milk and cheese were estimated by the Gerber procedure, protein and casein in milk by the formalin titration procedure, milk dry matter by calculation following the lactometric method and cheese dry matter by the atmospheric oven method as suggested by Marth (10). Corrections were made for temperature for dry matter in milk. Milk acidity was estimated by the titration procedure of Soxhlet-Henken described by Hensen (6).

Organoleptical characteristics

Milk color, odor and consistency were assessed visually or by the odor of the samples prior to cheese making. Milk was checked for the presence of unusual particles, scent and color.

Cheese making procedures

Prior to cheese making, milk was pasteurized by heating it on a gas burner up to 72°C, holding it for 20 sec, followed by rapid cooling with tap water. Cheeses similar to feta, saint-maure and queso de malaga (pressed-type) were manufactured as described by Kosikowski (7). The manufacturing steps are shown in figure 1.

For pressed-type cheese, started cultures (1 % v/v) were added to pasteurized milk at 31°C followed by rennet solution (3 ml per 10 kg of milk) under manual agitation. It was left quiescent for 1 h until coagulation took place. The curd was cut into small cubes of 1 x 1 x 1 cm with the knife and whey was allowed to separate for 15 min. The curd was heated to 37°C and left at that temperature for 60 min. The whey was poured off, the curd wrapped in the muslin cloth and pressed overnight with the wheeler press. It was removed from the press and salted in 200 g/l brine solution for 10 to 12 h. Cheese was matured for four weeks on the shelves at 20°C.

The feta-type cheese was manufactured as above except that after coagulation the curd was put in the form lined with cheese cloth. Whey was allowed to drain under light weight. The next day it was removed and dipped in a 200 g/l brine solution for 3 days. It was allowed to dry for 3 to 4 days on the shelf at 20°C. It was cut into cubes of about 200 g each ready for consumption. Milk for fresh white cheese was cultured with 2% v/v starter cultures. Rennet (0.1 ml for 10 l) was diluted and added to milk. The next day milk had coagulated and the curd was transferred into a muslin cheese cloth in a mold to allow for whey drainage. After 15 to 18 h, the curd was removed and dry-salted by sprinkling the surface. After maturation the cheese was ready for consumption.

■ RESULTS AND DISCUSSION

Milk composition

The fat, dry matter and protein contents of the collected milk samples are listed in table I. The fat content decreased from 44 g/l in April to its lowest value of 27 g/l in June. It then rose to a relatively constant high value from August to October.

Contrary to fat, the protein content increased from 29 g/l in April to 37 g/l in June. A small decrease was observed in July followed by a tendency to rise again in August and September.

Recorded values for the fat content were similar to those reported by Le Jaouen (8) for Nubian, Saanen and Toggenberg breeds.

The dry matter content was fairly constant throughout the rainy season except for lower values observed in the first months of the rainy season (April-June).

The values observed for the dry matter were much lower than those reported by Kosikowski (7) and Le Jaouen (8), their mean values being well over 140 g/l. The variations observed in the protein and fat composition were not surprising. The fat content of goat milk is influenced by the breed, production level, lactation stage, climatic factors and nutrition (4, 12). All these factors changed as lactation progressed through the rain season.

Variations in climatic conditions and particularly the state of the pastures seemed to affect the milk composition in terms of fat and protein. With rains falling in March, the vegetation changed from dry to green palatable grass. Starting in April goats had enough green pasture to feed on. By the month of July, the pastures were too wet with grass having a low dry matter content, making it difficult for goats to feed well. In October, the pastures became poor as the dry season approached and the grass was over mature. In the dry season there was very little good grass on the pastures for the goats to graze on.

Acidity values for the milk samples fell within the normal range of 6 to 8°SH (Soxhlet Henkel) acceptable for good quality fresh milk.

The milk obtained was whitish with a typical goat scent. The fatty material at the top was whitish confirming the absence of carotene. As no unusual color nor particles were found, it was suggested that milk could be used in cheese making.

The variations observed in the chemical composition could have some effects when the milk was used for cheese making. The low dry matter content of milk in the dry season reduced its coagulating properties as the milk coagulation time increased thus making it difficult to make cheese at this time of the year.

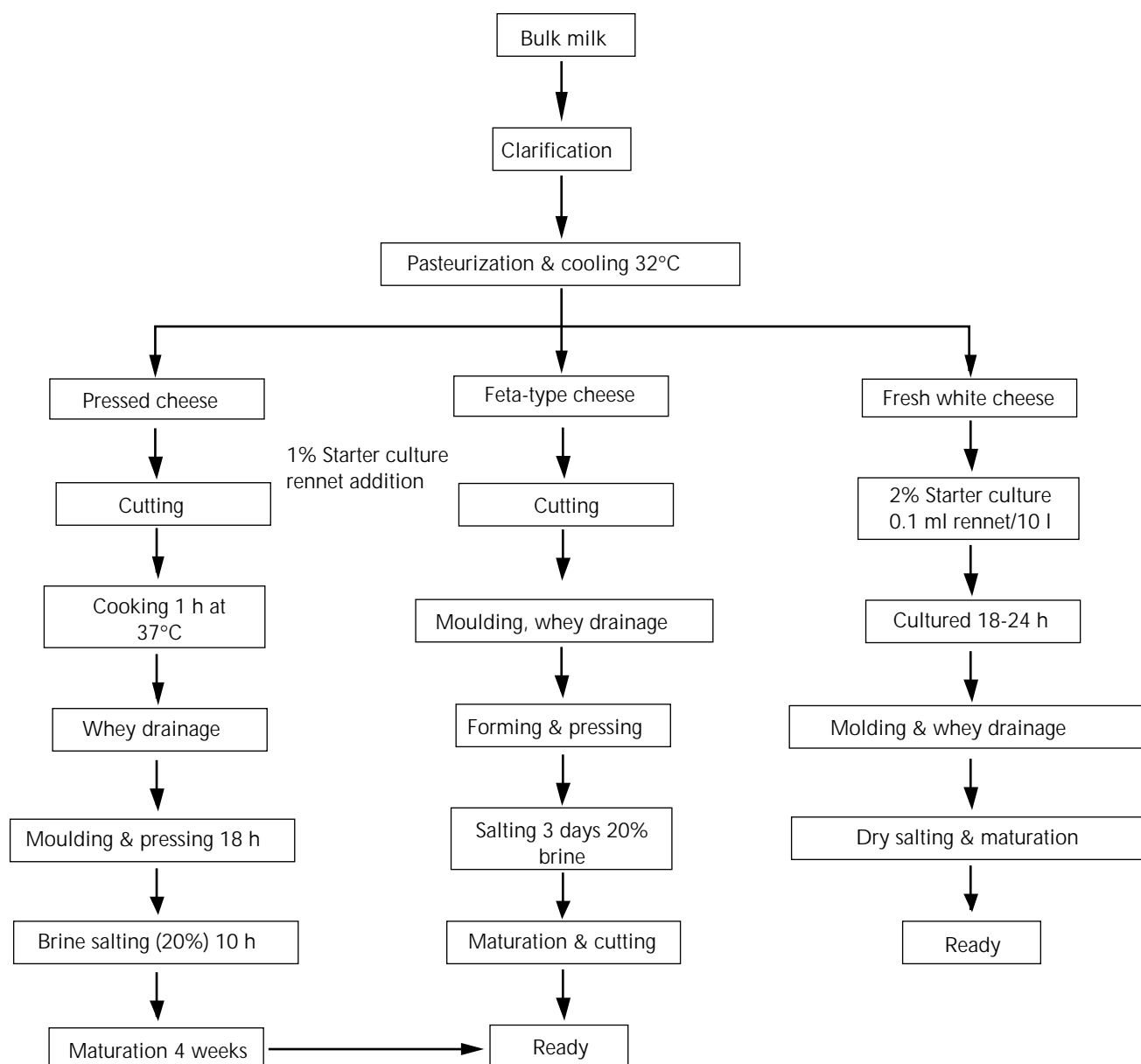


Figure 1: Schematic diagram of cheese making.

Table I

Variations in the composition of goat milk produced in the Highlands of Cameroon (n = 24)

Months	% Total dry matter	% Protein	% Fat	% Casein
	Means (min-max)	Means (min-max)	Means (min-max)	Means (min-max)
Dry season				
February*	9.7 (9.2-11.5)	3.9 (3.7-3.9)	3.6 (3.4-4.7)	2.0 (1.6-2.7)
Rainy season				
April	11.8 (9.9-13.7)	2.9 (2.8-3.0)	4.4 (4.1-4.6)	2.7 (2.6-3.0)
May	11.6 (11.0-11.9)	3.4 (2.9-3.8)	3.1 (3.0-3.3)	2.9 (2.9-3.0)
June	10.9 (10.7-11.2)	3.7 (3.6-3.7)	2.7 (2.5-3.0)	3.1 (2.7-3.6)
July	12.2 (11.6-12.7)	3.8 (3.5-4.2)	3.6 (3.4-3.6)	3.0 (2.9-3.1)
August	12.8 (12.7-12.9)	3.8 (3.7-4.0)	4.3 (4.0-4.4)	3.0 (3.0-3.1)
September	12.6 (12.3-12.9)	3.9 (3.4-4.2)	4.0 (3.7-4.3)	3.0 (3.0-3.1)
October	12.4 (12.2-13.4)	3.1 (2.9-3.4)	4.0 (3.2-4.5)	2.3 (1.9-2.6)

* Sample collected at the peak of the dry season

The reduction in the clotting ability of milk containing less dry matter was reported earlier by Ramet working with camel milk (13).

Cheeses and their composition

Fresh white cheeses similar to saint-maure, feta-type and pressed cheeses similar to queso de malaga were successfully manufactured. Some modifications were introduced to adapt the cheeses to the local environment. Fresh cheese weighed 200 g each and had a small cylinder shape from perforated plastic molds; a light weight was applied to enable it to take its shape. This helped packaging and distribution. Cheese yield and chemical composition are listed in table II.

Cheese yield was expressed as kilograms of cheese per 100 kg of milk as suggested by Gilles and Lawrence (5). For semi-hard cheeses, yields of 10 kg per 100 kg of cheese milk are acceptable (9). Cheese yields were 16.5, 16.8 and 15.0 kg per 100 kg of cheese milk for fresh white cheese, feta-type and pressed-type cheeses, respectively. The manufacturing procedure had some effects on the yield. Pressed cheeses had a lower yield compared to non-pressed cheeses. Pressing reduced the moisture content and openings in the cheese. Drying during maturation also reduced the moisture content and yields.

The yields observed were higher than those reported by O'Mahony and Peters (11) for feta cheese from cow milk and still lower than those for fresh white cheese reported by Veisseyre (15).

The differences observed in cheese yields from cow and goat milk could be attributed to the kind of dry matter, particularly the amount of milk casein. Goat milk is known to have a higher casein content and lower albumin and globulin contents compared to cow milk. In the present study a casein content as high as 35 g/l was observed. Gilles and Lawrence (5) observed increasing yields in cheese with increasing amounts of casein in cheese milk.

Some similarities were observed in the dry matter content of feta cheeses made from cow and goat milk. However the fat content was remarkably low in experimental feta cheeses despite the high fat content of cheese milk. Refrigerated storage of the milk must have allowed some fat separation as a cream layer was formed at the top. This fat was probably lost in the whey although a whey analysis was not carried out to confirm it. The whey was used for pig feeding.

The mean fat contents were 9.8, 19.0 and 25.0% w/w for fresh white cheese, feta-type and pressed-type cheeses, respectively. Similarly, cheese total dry matter was 42.2% w/w for fresh white cheese, 50.0% w/w for feta and 56.8% w/w for pressed-type cheeses. The variations observed in the cheese composition were a

reflection of those observed in the chemical composition of cheese milk. Milk containing less dry matter produced cheese with reduced yield. Milk with a low dry matter content had difficulty to form a firm gel under rennin action. This was the case during the dry season (February), thus restricting cheese making to the rainy part of the year.

These results agree with those reported earlier by Kosikowski (7) and Le Jaouen (8) for cheeses made from goat milk. All the cheeses had a fine texture characteristic of products made with lactic fermentation. However, the pressed-type cheese had the strongest flavor with the typical scent of goat cheese. Fresh cheese was the softest while pressed cheese was the hardest. The strong goat flavor was welcome by consumers who tended to appreciate the piquant and peppery sharp flavor of goat cheeses. The manufactured cheeses were good, and consumers' appreciation was very positive and tended to support the findings of Boor *et al.* (2), who reported no significant difference in acceptance between cow's and goat's milk and cheeses. From the texture, rigidity, hardness and dryness of all the cheeses, consumers' preference favored pressed cheeses first, then feta-type cheeses. Fresh white cheese was too soft and had a low-keeping quality at room temperature. Mold growth on the surface was a major set-back. Consumers preferred to take their cheese home and fresh cheese would tend to spread during transportation. Pressed-type cheeses could easily be carried to distant places and kept for a few days at room temperature (20°C). Its strong taste was in favor of its acceptability.

Shortly after this trial, the dairy goats were distributed to farmers as an attempt to introduce milk production from goats at the farm level. Unfortunately, the pure breed goats later disappeared due to age and no breeding program. A few crosses are still found on the research station today.

These results suggest the possibility of rearing goats for milk production in tropical areas, particularly in Cameroon. The excess milk could be used for cheese making even at the family level as it is the case in North Africa. The relative ease of keeping goats in a tropical environment is in favor of rearing goats for milk production. For a small scale producer, the technology employed is simple and quite reproducible. The equipment selected could be found at any local market. These results confirm the potentials and possibilities for goat milk transformation into cheese in these areas.

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Table II

Cheese composition and yields

Cheese types	% Fat	% Total dry matter	Yield (kg per 100 kg of milk)
	Means (min-max)	Means (min-max)	Means (min-max)
Fresh white cheese (n = 4)	9.8 (8.5-10.6)	42.2 (38.6-45.5)	16.5 (14.0-20.2)
Feta type (n = 7)	19.0 (15.7-25.1)	50.0 (46.6-51.4)	16.8 (15.7-18.7)
Pressed type (n = 5)	24.6 (23.5-25.2)	56.8 (49.8-62.4)	15.0 (12.7-17.1)

n = number of replicates

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Résumé

Kameni A., Imele H., Rubby F., Djoko D. Evaluation du lait de chèvre produit dans les Hauts Plateaux du Cameroun pour la fabrication de fromages

Le lait de chèvre produit par un troupeau de chèvres laitières à la Station de recherches zootechnique et vétérinaire de Mankon (IRZV) au Cameroun a été évalué pour son utilisation dans la fabrication de fromages. Ce troupeau comprenait des chèvres de race Toggenberg, Saanen et Nubienne. Les analyses chimiques ont montré que le lait produit en saison des pluies (avril-octobre) avait un taux de matières grasses compris entre 27 et 44 g/l, un taux de protéine entre 29 et 39 g/l et un taux de matière sèche entre 109 et 127 g/l. Le lait a été utilisé avec succès dans la fabrication de fromage frais, de fromage de type *feta* et de fromage à pâte pressée. Le taux moyen de matières grasses était de 9,8, 19,0 et 24,6 p. 100 respectivement pour le fromage frais, le fromage de type *feta* et le fromage à pâte pressée. Le taux de matière sèche était de 42,2 p. 100 pour le fromage frais, de 50,0 p. 100 pour le fromage de type *feta* et de 56,8 p. 100 pour le fromage à pâte pressée.

Mots-clés : Caprin - Lait - Fabrication fromagère - Afrique centrale - Cameroun.

Resumen

Kameni A., Imele H., Rubby F., Djoko D. Evaluación de la leche de cabra producida en las tierras altas de Camerún, para la fabricación de queso

Se evaluó la conveniencia para la producción de queso, de la leche de cabra fresca, producida por un hato de cabras lecheras en la estación Mankon del Instituto de investigaciones animales y veterinarias de Camerún (IRZV). Las razas de cabras involucradas fueron Toggenberg, Saanen y Nubiana. Los análisis químicos revelaron que la leche producida durante la estación lluviosa (de abril a octubre) presentó un contenido de grasa de 27 a 44 g/l, un contenido proteico de 29 a 39 g/l y un contenido de sólidos totales de 109 a 127 g/l. La leche se utilizó exitosamente para la fabricación de queso fresco, queso blanco fresco, queso tipo *feta* y queso tipo prensado, respectivamente. El contenido medio de grasa fue de 9,8, 19,0 y 24,6%, respectivamente. De la misma forma, los sólidos totales del queso fueron 42,2% para el queso blanco fresco, 50,0% para el tipo *feta* y 56,8% para el queso tipo prensado.

Palabras clave: Caprino - Leche - Fabricación de queso - Africa central - Camerún.