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Research Article

# Physico-Chemical and Hygienic Characteristics of the Calabrian Raw Milk Cheese, *Caprino d'Aspromonte*

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**Abstract:** The aim of the present research was the study of several physico-chemical and hygienic characteristics of *Caprino d'Aspromonte* goat's cheese, made from raw milk, which was sampled at the end of the ripening time (4 weeks), both in winter and in spring. The following ranges of variability were observed for each parameter: pH 5.25-5.89, dry matter 49.89%-67.07%, crude protein 21.12%-42.32% dry matter, fat 43.85%-54.03% dry matter, chloride content 2.06%-5.44% dry matter, total coliforms 0-5.04 log cfu $g^{-1}$, faecal coliforms 0-4.96 log cfu $g^{-1}$, yeasts 2.60-4.95 log cfu $g^{-1}$. These values were similar to those of other Mediterranean goat's milk cheeses with an analogous ripening time. The present data could constitute basic information useful for improving and promoting *Caprino d'Aspromonte*, as well as for defining its production.

**Key Words:** Goat's cheese, raw milk, seasonal changes

## Introduction

In the Mediterranean basin, raw milk cheeses are typical products whose quality is strongly influenced by the local production area and by its traditions. In fact, these cheese making processes are based on the interaction between pedoclimatic characteristics and anthropic factors, in particular, combinations that are difficult to reproduce elsewhere. Artisanal production of the *Caprino d'Aspromonte* cheese, made from raw, whole, non-pasteurised goat's milk, mixed with a 20% maximum of ewe's milk, is widespread in the Calabrian Aspromonte Massif. This cheese is produced without the addition of selected starter cultures and, therefore, the existing microflora is autochthonous and originates from both the milk and the environment. Cheese making is carried out using artisanal methods and traditional tools; all the phases are manual. The evening milk, left at room temperature, together with the morning milk is filtered, poured into a round-bottomed vat of tin-plated copper, and slightly warmed to 25-30 °C before the addition of rennet. The rennet is always prepared by salting and sun-drying the abomasums of suckling kids, after which it is mixed with more salt to form a paste that is kept in the refrigerator. About 3 g of this paste is suspended in lukewarm water, filtered through cloth, and used to coagulate about 100 l of milk. Then, 30-50 min after adding rennet, the resulting curd is manually broken up into grain-sized pieces, using an artisanal wooden tool. The curd is then compacted and transferred onto a sloping table to facilitate drainage, after which it is firmly pressed by hand into moulds. At this stage, forms are strewed with the salt that the cheese spontaneously retains, and then again after 24 h. After this, the forms are removed from their moulds and placed on a wooden rack in a storage room where they are frequently turned and cleaned. In order to obtain soft cheese, ripening is carried out for 20-30 days; to produce hard cheese, ripening is protracted for 4-5 months. Physico-chemical, lacto-dynamographic, and microbiological characteristics of the goat's milk employed in *Caprino d'Aspromonte* production have been previously studied by us (1). Moreover, during the cheese ripening, the main physico-chemical and microbiological parameters have been evaluated (2).

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The aim of the present work was to investigate the physico-chemical and hygienic characteristics of the soft cheese *Caprino d'Aspromonte* ripened for 4 weeks.

## Materials and Methods

Ten artisanal farms, located in the province of Reggio Calabria, producing *Caprino d'Aspromonte* according to traditional methods, and representative of the full production area were chosen. For each farm, 3 cheeses at the end of the ripening time (4 weeks) were sampled, both in winter and in spring. The samples were transported in a refrigerated container and stored in a laboratory at 4 °C until analysis, which was performed within 2 days.

After removal of the rind, the cheeses were finely grated and analysed by standard methods (3) for the following physico-chemical parameters: pH, dry matter, fat content, crude protein, and chloride content. Fat and crude protein contents were expressed as a percentage of the dry matter.

To perform the microbiological analysis, after removal of the rind for each cheese, a 10-g slice, inclusive of inner, intermediate, and outer parts, was cut and homogenised for 2 min with 90 ml of physiological sterile saline (0.9% NaCl) using a blender. After filtering through sterile gauze, 1-ml aliquots of the homogenate and its decimal dilutions in physiological sterile saline were plated in duplicate on selective media. Total coliforms were grown, according to Nuñez (4), on Violet Red Bile Agar (Fluka, Ref. 70188, Buchs, Switzerland) prepared using the double layer technique and incubated aerobically at 37 °C for 24 h. Faecal coliforms were determined on 3M™ Petrifilm™ for *Escherichia coli* and coliforms (3M Microbiology Products, Ref. 34-7048-4171-6, St. Paul, MN, USA) incubated aerobically at 37 °C for 48 h (5). Yeasts were determined on Yeast Extract Glucose Chloramphenicol Agar (Fluka, Ref. 95765, Buchs, Switzerland) incubated aerobically at 22 °C for 96 h, after assessment of microbial macro- and micro-morphology. After calculating the colony forming units (cfu) per gram of cheese, data were converted into logarithmic form.

## Results

The pH of the winter samples (Figure 1a) showed a mean value of 5.67, with a minimum of 5.25 (farm 3) and a maximum of 5.89 (farm 7). The spring samples exhibited a mean value of 5.42, with a minimum of 5.26 (farm 7) and a maximum of 5.73 (farm 10).

The cheeses produced in winter showed a mean dry matter value of 56.68% (Figure 1b), ranging from 49.89% (farm 9) to 64.61% (farm 6), while those produced in spring had a mean value of 62.71%, with a minimum of 58.51% (farm 6) and a maximum of 67.07% (farm 7).

Crude protein content, expressed as a percentage of dry matter (Figure 1c), in the samples produced in winter had a mean value of 36.22%, with a minimum of 31.19% (farm 8) and a maximum of 42.32% (farm 3). The samples produced in spring exhibited lower values, with a mean of 26.49% and a range of 21.12% (farm 7) to 30.93% (farm 3).

The fat content, expressed as a percentage of dry matter (Figure 1d), showed a mean value of 47.43%, with a minimum of 45.29% (farm 10) and a maximum of 54.03% (farm 1) for the samples produced in winter, while for cheeses produced in spring the mean value was 46.76%, with a minimum of 43.85% (farm 3) and a maximum of 50.98% (farm 5).

The chloride content, expressed as a percentage (Figure 2a), had a mean value of 2.09%, ranging from 1.10% (farm 5) to 2.43% (farm 7) for cheeses produced in winter, while results obtained from cheeses produced in spring were slightly higher and showed a mean value of 2.58%, with a minimum of 1.87% (farm 9) and a maximum of 3.44% (farm 4).

For the samples produced in winter, the total coliform content, expressed as log cfu $g^{-1}$ of cheese (Figure 2b), had a mean value of 4.37, with a minimum of 3.48 (farms 3 and 10) and a maximum of 5.04 (farm 7). These values were sharply higher than those observed in the samples produced in spring, which had a mean value of 2.32 and a maximum of 3.84 (farm 7). Total coliforms were not detected in the samples from farms 2 and 8.

The cheese samples produced in winter had a mean value of faecal coliform content, expressed as log cfu $g^{-1}$ of cheese (Figure 2c), of 4.13, with a minimum of 2.18 (farm 8) and a maximum of 4.96 (farm 7). These values were lower than the limit established by Italian legislation of 100,000 cfu $g^{-1}$ of cheese (6). The cheeses produced in spring showed values lower than those observed in winter samples, exhibiting a mean value of 1.37 and a

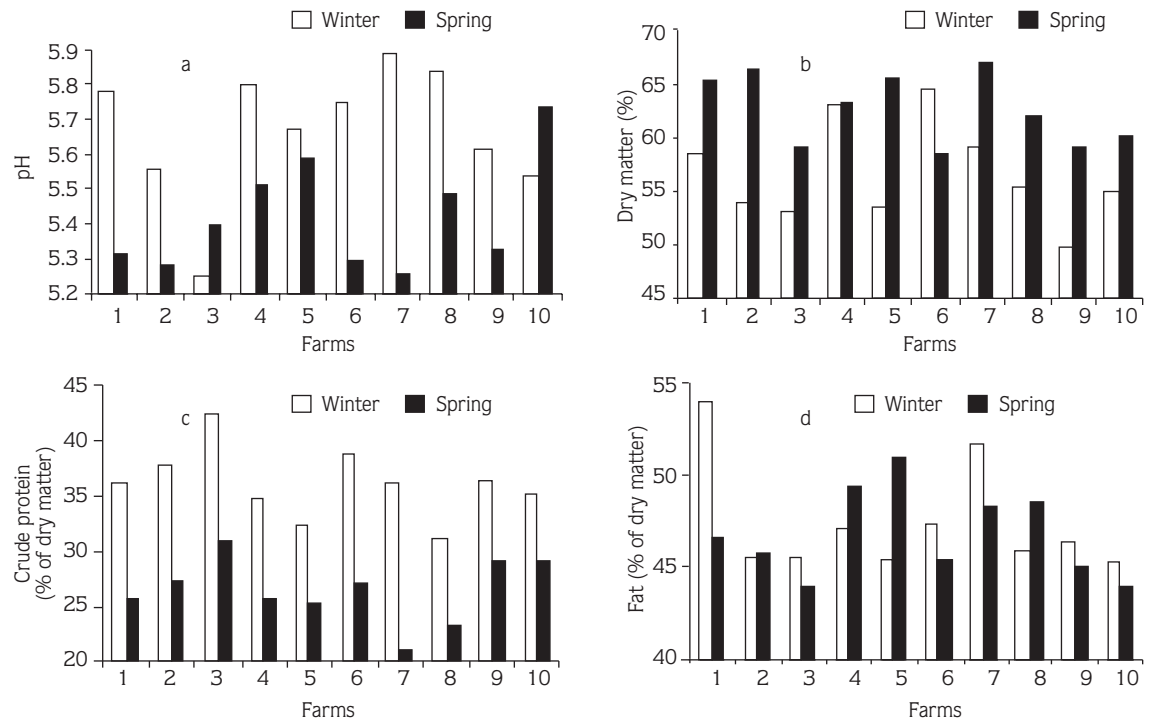


Figure 1. pH (a), dry matter (b), crude protein (c), and fat content (d) of cheeses produced in winter and in spring.

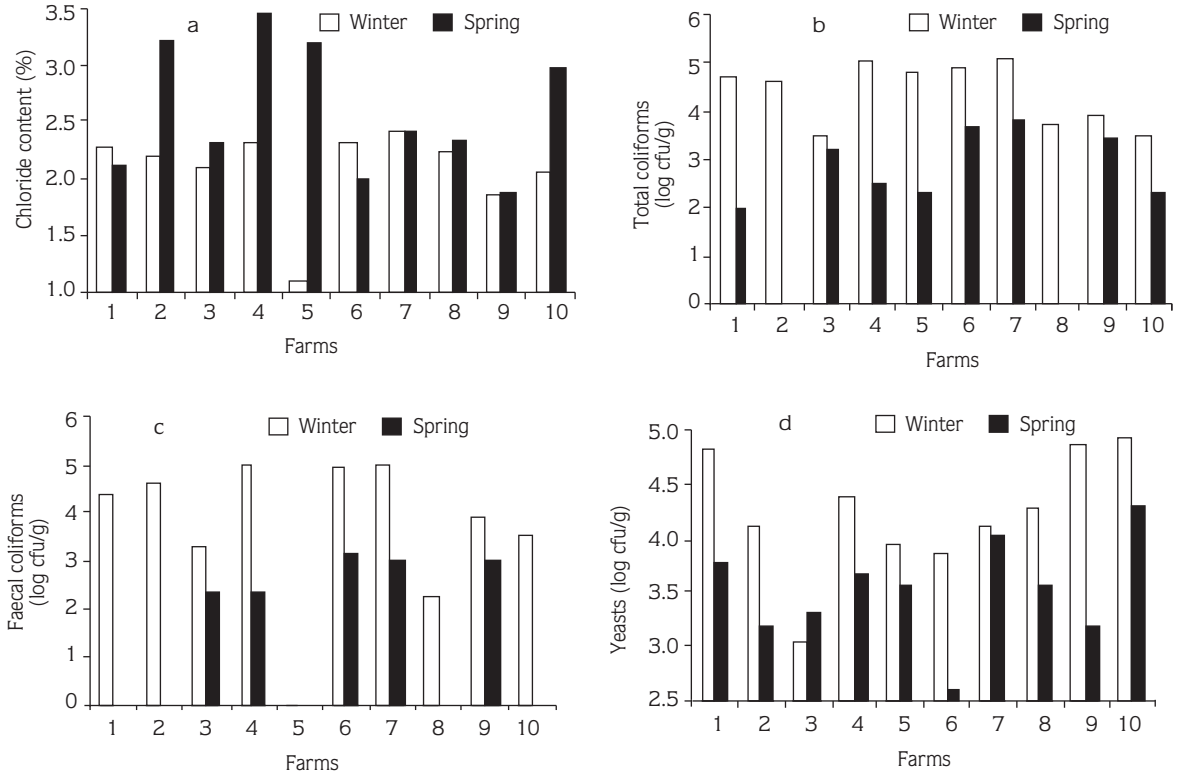


Figure 2. Chloride content (a), total coliforms (b), faecal coliforms (c), and yeast content (d) of cheeses produced in winter and in spring.

maximum of 3.11 (farm 6). Faecal coliforms were not detected in the samples from farms 1, 2, 5, 8, and 10.

Yeast content, expressed as log cfu $g^{-1}$ of cheese (Figure 2d), had a mean value of 4.25, with a minimum of 3.04 (farm 3) and a maximum of 4.95 (farm 10) in the samples produced in winter, while in those produced in spring the mean value was 3.53, with a minimum of 2.60 (farm 6) and a maximum of 4.32 (farm 10).

## Discussion

The pH values observed in this study for *Caprino d'Aspromonte* were similar to those reported for other goat's milk cheeses. In particular, 30-day-old *Batzos* Greek cheese (7) had a pH value of 5.63 in winter and 5.34 in spring. Moreover, 40-day-old *Caprino umbro* (8) had a mean value of 5.5. Spanish cheeses, however, exhibited lower pH values: 30-day-old *Armada* from 4.30 to 4.55 (9,10), 30-day-old *Babia-Laciana*, 4.40 (11), 30-day-old *Ibores*, 4.69 (12), 30-day-old *Tenerife*, 4.64 (13), and 27-day-old *Valdeteja*, 4.48 (14). Furthermore, 60-day-old *Teleme* Greek goat's milk cheese (15) had a lower pH value (4.39). Overall, the pH of *Caprino d'Aspromonte* showed moderate difference, both among the farms and between the 2 periods of production. In our opinion, the observed differences among the farms depended, above all, on a dissimilar degree of hygienic conditions during both milking and cheese processing; consequently, more careful hygienic management would notably reduce the observed variability. Moreover, this phenomenon might have been due to differences in the counts of lactic acid bacteria and to the technological procedures followed in cheese making. The same applies to the seasons, which bring with them changes in microflora. Such changes bring about variation in certain physical and chemical parameters, like pH. With the exception of farms 3 and 10, cheeses produced in spring had a pH value lower than cheeses produced in winter. This season-dependent characteristic, also reported for *Anevato* Greek cheese (16), may possibly be connected to the growth of lactic acid bacteria with different abilities for lactic acid production.

Dry matter showed great variation, both among the farms and between the periods of production. The higher values observed in cheeses produced in spring are attributable to the higher dehydration due to the different climatic conditions of ripening (2). A similar trend was reported for *Batzos*, which had a winter dry matter mean value of 50.14% and a spring mean value of 59.8% (7). Dry matter values similar to those of *Caprino d'Aspromonte* produced in winter were reported for 30-day-old *Ibores* (56.54%) (12), while 40-day-old *Caprino umbro* (69.47%) (8), 30-day-old *Armada* (69.27%) (9), 30-day-old *Babia-Laciana* (71.7%) (11), and 27-day-old *Valdeteja* (73.55%) (14) had higher dry matter content. Much lower values (46.8%) were reported for 30-day-old *Tenerife* (13).

In addition, for crude protein content, great variation both among farms and production periods were observed, with higher values for cheeses obtained in winter. Very similar values to *Caprino d'Aspromonte* produced in winter were reported for 30-day-old *Armada* (9) and *Babia-Laciana* (11) with respective mean values of 34.3% and 31.5%.

The fat content showed moderate variation, both among the farms and between the production periods, and was always higher than 42%. Higher fat values were reported for 30-day-old *Babia-Laciana* (11) and *Armada* (9), reaching 62.7% and 60.65%, respectively, and for 30-day-old *Caprino umbro* (59%) (8).

Considering chloride content, great differences, both among the farms and between the production periods, were observed due to the different amounts of salt used by each producer. Differences in salt content can, to some extent, affect the development of lactic acid bacteria and can have an impact on the evolution of pH values. A reduction of the existing variability among the farms in the amount of salt added to the cheese may be useful in order to standardise the production process. Chloride content values very similar to those of *Caprino d'Aspromonte* were described for 30-day-old *Armada* (1.72%) (9) and 27-day-old *Valdeteja* (1.85%) (14). A lower chloride content value was recorded for 30-day-old *Babia-Laciana* (0.86%) (11). Much higher chloride content values were reported for 60-day-old *Teleme* Greek goat's milk cheese (6.17%) (15) and for 30-day-old *Tenerife* (4.36%) (13).

Great differences among farms were observed for the total coliform content of *Caprino d'Aspromonte* due to different hygienic conditions during the milking and cheese making processes. The differences connected with the production period, however, were not immediately explicable and should be carefully investigated. The

differences observed in coliform content between the 2 production periods could be related to changes in pH or chloride content, and hence with changes in lactic acid bacteria. Nonetheless, the lowest values were observed in the spring samples of *Caprino d'Aspromonte*. Other goat's milk cheeses showed higher values than those of *Caprino d'Aspromonte* produced in winter, such as 30-day-old *Majorero* (5.48%) (17), 10-day-old *Caprino Sardo* (4.90%) (18), and 40-day-old *Caprino umbro* (4.52%) (8). A lower total coliforms content of 3.55% and 3.50% was described for 30-day-old *Tenerife* (13) and for a 30-day-old Greek brine-ripened cheese (19), respectively.

Considering the faecal coliform content, great differences among the farms and between production periods were observed for *Caprino d'Aspromonte*, with higher values for the cheeses produced in winter. Low total and faecal coliforms content similar to the values observed in the spring samples of *Caprino d'Aspromonte* cheese were also reported for other 30-day-old Spanish goat cheeses made from raw milk, such as *Cendrat del Montsec* (20), *Gredos* (21), *Ibores* (12,22), and *Tenerife* (13).

Wide variation was observed for yeast content of *Caprino d'Aspromonte*, both among the farms and between the periods of production. Similarly, yeast content of other goat's cheeses exhibit a wide variability; low values were observed for 30-day-old *Batzos* (2.44 and 2.66 for winter and spring productions, respectively) (7), intermediate values for 60-day-old Greek brine-ripened cheese (3.86) (19), and high values for 30-day-old *Tenerife* (4.66) (13) and *Caprino Sardo* (5.24) (18).

Overall, variability among the farms regarding both the microbiological and the physico-chemical profiles was observed. Certainly, greater care from the hygienic point of view may be very useful in order to improve results, and hence to reduce the noticed differences. In contrast, the physico-chemical differences observed among the farms are peculiar traits of this typical production and have to be considered a supplementary value of this product, as long as they do not exceed the animal-individual variability and the artisanal technological peculiarity of each producer of the *Caprino d'Aspromonte* cheese. The present data could constitute, therefore, basic information useful for improving and promoting the *Caprino d'Aspromonte* cheese, as well as for defining its production.

## References


1. Micari, P., Caridi, A., Colacino, T., Foti, F., Ramondino, D.: Characteristics of goat milk produced in the Aspromonte massif (Calabria, Italy). Ital. J. Food Sci., 2002; 14: 363-374.
2. Caridi, A., Micari, P., Foti, F., Ramondino, D., Sarullo, V.: Ripening and seasonal changes in microbiological and chemical parameters of the artisanal cheese *Caprino d'Aspromonte* produced from raw or thermized goat's milk. Food Microbiol., 2003; 20: 201-209.
3. Bradley, R.L., Arnold, E., Barbano, D.M., Semerad, R.G., Smith, D.E., Vines, B.K.: Chemical and physical methods. In: Marshall, R.T., Ed. Standard Methods for the Examination of Dairy Products. APHA (American Public Health Association) Inc. Washington, DC, USA, 1993; 433-531.
4. Nuñez, M.: Microflora of Cabrales cheese: changes during maturation. J. Dairy Res., 1978; 45: 501-508.
5. Nordic Committee of Food Analysis, method n°147, 1993.
6. Official Gazette of the Italian Republic, Ordinary Supplement n°59, 1997 (12 March).
7. Psoni, L., Tzanetakis, N., Litopoulou-Tzanetaki, E.: Microbiological characteristics of Batzos, a traditional Greek cheese from raw goat's milk. Food Microbiol., 2003; 20: 575-582.
8. Clementi, F., Cenci Goga, B.T., Trabalza Marinucci, M., Di Antonio, E.: Use of selected starter cultures in the production of farm manufactured goat cheese from thermized milk. Ital. J. Food Sci., 1998; 10: 41-55.
9. Fresno, J.M., Tornadijo, M.E., Carballo, J., Gonzàlez-Prieto, J., Bernardo, A.: Characterization and biochemical changes during the ripening of a Spanish craft goat's milk cheese (Armada variety). Food Chem., 1996; 55: 225-230.
10. Tornadijo, M.E., Fresno, J.M., Bernardo, A., Sarmento, R.M., Carballo, J.: Microbiological changes throughout the manufacturing and ripening of a Spanish goat's raw milk cheese (Armada variety). Lait, 1995; 75: 551-570.
11. Franco, I., Prieto, B., Bernardo, A., Gonzàlez Prieto, J., Carballo, J.: Biochemical changes throughout the ripening of a traditional Spanish goat cheese variety (Babia-Laciana). Int. Dairy J., 2003; 13: 221-230.
12. Gonzalez, J., Mas, M., Tabla, R., Moriche, J., Roa, I., Rebollo, J.E., Càceres, P.: Autochthonous starter effect on the microbiological, physicochemical and sensorial characteristics of Ibores goat's milk cheeses. Lait, 2003; 83: 193-202.
13. Zárate, V., Belda, F., Pèrez, C., Cardell, E.: Changes in the microbial flora of Tenerife goats' milk cheese during ripening. Int. Dairy J., 1997; 7: 635-641.

14. Alonso-Calleja, C., Carballo, J., Capita, R., Bernardo, A., Garcìa-Lòpez, M.L.: Changes in the microflora of Valdeteja raw goat's milk cheese throughout manufacturing and ripening. Lebensm. Wiss. Technol., 2002; 35: 222-232.

15. Mallatou, H., Pappa, E., Massouras, T.: Changes in free fatty acids during the ripening of Teleme cheese made with ewes', goats', cows' or a mixture of ewes' and goats' milk. Int. Dairy J., 2003; 13: 211-219.

16. Hatzikamari, M., Litopoulou-Tzanetaki, E., Tzanetakis, N.: Microbiological characteristics of Anevato: a traditional Greek cheese. J. Appl. Microbiol., 1999; 87: 595-601.

17. Fontecha, J., Pelaez, C., Juárez, M., Requena, T., Gómez, C., Ramos, M.: Biochemical and microbiological characteristics of artisanal hard goat's cheese. J. Dairy Sci., 1990; 73: 1150-1157.

18. Fatichenti, F., Deiana, P., Farris, G.A., Soggia, G.: Études microbiologiques sur le lait et le fromage de chèvre en Sardaigne. Lait, 1979; 59: 387-399.

19. Litopoulou-Tzanetaki, E., Tzanetakis, N.: Microbiological study of white-brined cheese made from raw goat milk. Food Microbiol., 1992; 9: 13-19.

20. Mor-Mur, M., Carretero, C., Pla, R., Guamis, B.: Microbiological changes during ripening of Cendrat del Montsec, a goats' milk cheese. Food Microbiol., 1994; 11: 177-185.

21. Medina, M., Gaya, P., Nuñez, M.: Gredos goats' milk cheese: microbiological and chemical changes throughout ripening. J. Dairy Res., 1992; 59: 563-566.

22. Mas-Mayoral, M., Timón-Esteban, J., González-Crespo, J.: Ibores cheese: production, physico-chemical and microbiological characteristics. Arch. Zootecnia, 1991; 40: 103-113.