

## Effect of donkey milk addition on the acceptability of Caprino, a typical goat cheese from Basilicata region, Italy

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*In this preliminary study we evaluated the effect of different donkeys' milk additions in cheese making on the acceptability of fresh Caprino, a typical goat cheese produced in a region of southern Italy. In cheese making three batches were considered: A1 only goats' milk, A2 and A3 with the addition of 5% and 10% of donkeys' milk, respectively. With the exception of colour, the lowest donkeys' milk addition improved the acceptability of Caprino cheese. In particular, significant highest ratings ( $P < 0.05$ ) were observed on odour, flavour, texture and on overall liking.*

**Keywords** Caprino cheese, Goat cheese acceptability, Donkey milk.

In Italy, goats and donkeys are mostly reared in the South-Center, probably due to the well adaptation of the species to browsing or grazing in marginal lands. Goats' milk is mainly delivered for cheese making, while the renewed interest toward donkeys' milk is mainly motivated by its chemical composition and nutrient contents, which have made it similar to human milk (Cosentino *et al.* 2016). Moreover this milk is utilised in the geriatric field for the treatment of some aging diseases (Hernández-Ledesma *et al.* 2006). In cheese making the interest toward donkey milk is related to its lysozyme content, as it ranges from 1.0 to 3.7 mg/mL, much higher than in cow (0.18 µg/mL) or in goat milk (0.25 µg/mL) (Cosentino *et al.* 2016; Labella *et al.* 2016). For this reason, donkeys' milk has been recently tested as an inhibitor of late gas production defects during ripening in bovine cheeses (Cosentino *et al.* 2015; Niro *et al.* 2021) and in a mixed bovine-ovine cheese (Ozturkoglu-Budak *et al.* 2021) as alternative of hen egg white lysozyme, which can cause severe allergic reactions (Cosentino *et al.* 2015; Niro *et al.* 2021). These studies have also highlighted that the addition of donkeys' milk did

not reduce the acceptability of the product, even improving it in some appearance descriptors (structure and uniformity), sweetness intensity (Cosentino *et al.* 2016). Moreover, a recent study (Ozturkoglu-Budak *et al.* 2021), in which lysozyme and lactoferrin extracted from donkeys' milk were compared to chemical additives in production of Kashar cheese, evidenced the best values in terms of taste and flavour in cheese produced with natural protein addition. The nutritional and health aspects of goat cheese have led to growing interest of consumers. However many of them, especially the occasional ones, prefer mainly goat cheeses with a not particularly marked goaty aroma. In this study, in light of this consideration and also of the first encouraging results on the above mentioned studies on bovine cheeses, we evaluated the acceptability of fresh Caprino produced with two different additions of donkeys' milk. Caprino cheese is a traditional Italian agri-food product (P.A.T.) from Basilicata region included in a special list of the Ministry of Agricultural, Food, and Forestry (MIPAAF 2021). It is made with raw caprine milk and rennet and, sometimes, it is even additionally flavoured with

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rocket and thyme. Its cylindrical shape is 8–12 cm high and has a diameter of 15–20 cm. Weight ranges from 0.5 to 1 kg. The aged type is left to mature for up to 6 months and during ripening it develops much saltier and spicy flavour, turns its colour from white to ivory with sparse and irregularly distributed holes. Fresh Caprino is ripened between for two to four days.

Milk collection and analysis – Fresh raw goats' and donkeys' milk were collected the same day by a mechanical milking apparatus. Bulk milk was taken from 2 different farms situated in Basilicata region. Milk from pluriparous autochthonous dairy goats and Martinafranca breed jennies was collected and refrigerated at 4 °C. Milk samples were transported to the laboratory to determine the content of protein, fat, lactose (IDF 1995; ISO 2013), dry matter (DM) and ash (AOAC 1990). All measurements were carried out in triplicate. Goats' milk contained, on average, 29.7 g/kg protein, 48.8 g/kg fat, 38.6 g/kg lactose, 136.0 g/kg DM, and 8.0 g/kg ash content. Donkeys' milk had the following composition: 17.0 g/kg protein, 13.0 g/kg fat, 64.0 g/kg lactose, 96.0 g/kg DM, and 4.0 g/kg ash.

Cheese making - Goats' milk was first pasteurized at 65 °C for 30 min and subsequently cooled down to 28 °C. Donkeys' milk was not thermized, because in donkey milk the heat-treatment changes the proteins conformation, with negative results during enzymatic reaction (Iannella 2015). A fixed amount of milk (100 L for each vat) was poured in 3 different vats in order to consider three different thesis: A1 (only goats' milk, control group), A2 (5% donkeys' milk addition) and A3 (10% donkeys' milk addition). Each vat was inoculated at 28 °C with a mesophilic starter culture of *Lactococcus lactis* subsp. *lactis* (6 g/hL; M030N, Sacco; Como, Italy). After 1 h, *Bifidobacterium bifidum* (2 g/hL; Prodor; Piacenza, Italy) was added to the milk. After 3 h fermentation, liquid calf rennet (10 mL/hL; strength units 1:10 000; chymosin to pepsin ratio 80:20; Prodor; Piacenza, Italy) was added to the milk, and the curd was allowed to stand for 24 h at 27–28 °C. After whey draining, the curd obtained was placed into round plastic molds with a diameter of 15 cm, dry salted and matured for 2 days at 10–15 °C and 70% of relative humidity. The whole experiment was repeated twice.

Cheeses were sampled according to the IDF (1995) procedure to perform the following parameters: pH (pHmeter HI98161, Hanna Instruments, Padova, Italy), protein, fat, (NIR System 5000, Foss), DM and ash content (AOAC 1990).

For the evaluation of acceptability we have chosen habitual consumers of fresh cheese (not just goat cheese) because, having a taste more oriented towards products with a less strong taste, they could have better appreciated differences, even slight, among the theses. Consumer recruitment (38 males and 42 females, aged between 21–62 years) was carried out by placing advertisements across the University of Basilicata campus. A small amount (20 g) of each type

of cheese was identified by random 3-digit codes and served in random order under white fluorescent lighting to consumers. They were asked to evaluate colour, odour, flavour, texture and overall liking by a 9-point hedonic scale (Cosentino *et al.* 2021). The consumer test was performed in individual booths. Data were subjected to one-way ANOVA, and means were compared by Tukey's HSD.

The addition of donkeys' milk influenced significantly DM, protein, and fat contents in cheese, with lower values in A3 related to the greater addition of donkeys' milk (Table 1). Protein contents of A2, and A3 cheeses resulted slightly higher than that observed (171 g/kg) on a fresh cheese made with a mixture of donkeys' and goats' milk by Faccia *et al.* (2018). With the exception of colour, donkeys' milk addition influenced statistically the acceptability of cheese (Table 2). In particular, significant highest ratings ( $P < 0.05$ ) were observed in A2 thesis on odour, flavour, texture and on overall liking. The overall liking rating of A2 cheese was near to be 'like very much' in the evaluation scale. Niro *et al.* (2021), on Grana Padano cheese, and Cosentino *et al.* (2016) on cow cheese found that the addition of donkey milk aliquots significantly improved several microbiological and chemical-physical aspects that, in agreement with Faccia *et al.* (2020), could be attributed to a diminished caprine taste, and to a higher sweet taste. Conversely, cheese made with the highest amount of donkeys' milk showed significant lowest scores on odour, flavour, texture and overall liking parameters. Texture, may have been affected by the dilution effect of donkeys' milk towards caseins and fat content. A sensory analysis by an expert panel may be very useful for identifying sensory attributes characterizing Caprino cheese made with different jenny milk additions.

In conclusion, the addition of a small amount of donkeys' milk in Caprino cheese making would allow an even more pleasant product to be obtained and, probably, characterized by a longer shelf life due to the bacteriostatic action of donkey milk, already highlighted in a cow cheese (Cosentino *et al.* 2015). An ongoing study on the topic may perhaps consolidate this hypothesis. Moreover, non-regular consumers who prefer more neutral goat cheese, with a taste

**Table 1** Cheese chemical parameters (mean  $\pm$  SD).

Parameter	A1	A2	A3
Dry matter, g/kg	492.8 <sup>a</sup> $\pm$ 44.35	487.7 <sup>a</sup> $\pm$ 41.8	478.0 <sup>b</sup> $\pm$ 54.2
Protein, g/kg	192.5 <sup>a</sup> $\pm$ 15.4	190.3 <sup>ab</sup> $\pm$ 24.7	187.0 <sup>b</sup> $\pm$ 20.6
Fat, g/kg	227.0 <sup>a</sup> $\pm$ 23.4	221.1 <sup>ab</sup> $\pm$ 26.5	216.5 <sup>b</sup> $\pm$ 28.1
Ash, g/kg	28.3 $\pm$ 3.11	31.3 $\pm$ 4.38	29.5 $\pm$ 4.1
pH	4.20 $\pm$ 0.11	4.18 $\pm$ 0.14	4.15 $\pm$ 0.12

A1: only goat milk; A2: 5% addition of donkey milk; A3: 10% addition of donkey milk.

<sup>a,b</sup> $P < 0.05$ .

**Table 2** Consumer liking scores (mean  $\pm$  SD).

Cheese	Colour	Odour	Flavour	Texture	Overall liking
A 1	7.56 $\pm$ 1.50	7.25 <sup>a</sup> $\pm$ 1.48	6.96 <sup>a</sup> $\pm$ 1.75	7.48 <sup>a</sup> $\pm$ 1.28	7.08 <sup>a</sup> $\pm$ 1.66
A 2	7.92 $\pm$ 0.95	7.23 <sup>a</sup> $\pm$ 1.38	7.35 <sup>b</sup> $\pm$ 1.74	7.48 <sup>a</sup> $\pm$ 1.48	7.62 <sup>b</sup> $\pm$ 1.63
A 3	7.50 $\pm$ 1.54	6.81 <sup>b</sup> $\pm$ 1.58	6.46 <sup>a</sup> $\pm$ 1.83	7.12 <sup>b</sup> $\pm$ 1.64	6.85 <sup>a</sup> $\pm$ 1.74

A1: only goat milk; A2: 5% donkey milk addition; A3: 10% donkey milk addition.

<sup>a,b</sup>*P* < 0.05.

similar to that of cow, could also appreciate this product (Ryffel *et al.* 2008). Processing of dairy products by using mixtures of goat and donkey milk could be an interesting and feasible opportunity for the local dairy sector, producing cheese as a high-quality functional food, thus having a potential impact on the market. Moreover the use of donkey milk may also have positive implications for existing donkey farms as well as as for the conservation or reintroduction of this species in marginal areas (Cosentino *et al.* 2015).

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## AUTHOR CONTRIBUTIONS

**Rosanna Paolino:** Writing – original draft. **Pierangelo Freschi:** Supervision; writing – review & editing. **Salvatore Claps:** Data curation; methodology. **Simona Tarricone:** Data curation. **Lucia Sepe:** Formal analysis. **Carlo Cosentino:** Investigation; project administration.

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## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

## REFERENCES

- AOAC (1990) *Official Methods of Analysis*, 15th edn, Vol. II, pp. 840–850. Arlington, VA: Association of Official Analytical Chemists.
- Cosentino C, Colonna M A, Musto M, Dimotta A, Freschi P, Tarricone S, Ragni M and Paolino R (2021) Effects of dietary supplementation with extruded linseed and oregano in autochthonous goat breeds on the fatty acid profile of milk and quality of Padraccio cheese. *Journal of Dairy Science* **104** 1445–1453.
- Cosentino C, Faraone D, Paolino R, Freschi P and Musto M (2016) Short communication: Sensory profile and acceptability of a cow milk cheese manufactured by adding jenny milk. *Journal of Dairy Science* **99** 228–233.
- Cosentino C, Paolino R, Valentini V, Musto M, Ricciardi A, Adduci F, D'Adamo C, Pecora G and Freschi P (2015) Effect of jenny milk addition on the inhibition of late blowing in semihard cheese. *Journal of Dairy Science* **98**, 5133–5142.
- Faccia M, Gambacorta G, Martemucci G, Natrella G and D'Alessandro A G (2018) Technological attempts at producing cheese from donkey milk. *Journal of Dairy Research* **85** 327–330.
- Faccia M, Gambacorta G, Martemucci G, Difonzo G and D'Alessandro A G (2020) Chemical-sensory traits of fresh cheese made by enzymatic coagulation of donkey milk. *Foods* **9** 16.
- Hernández-Ledesma B, Ramos M, Recio I and Amigo L (2006) Effect of  $\beta$ -lactoglobulin hydrolysis with thermolysin under denaturing temperatures on the release of bioactive peptides. *Journal of Chromatography A* **1116** 31–37.
- Iannella G (2015) Donkey cheese made through pure camel chymosin. *African Journal of Food Science* **9** 421–425.
- IDF (1995) *Milk and Milk Products: Guidance on Sampling*. Standard 50C. 1st edn, pp. 11–19. Brussels, Belgium: International Dairy Federation (IDF).
- ISO (2013) *Milk and Liquid Milk Products-Guidelines for the Application of Mid-infrared Spectrometry (ISO 9622: 2013/IDF 141:2013)*, 2nd edn, pp. 5–14. Geneva, Switzerland: International Organization for Standardization.
- Labella C, Lelario F, Bufo S A, Musto M, Freschi P and Cosentino C (2016) Optimization and validation of a chromatographic method for quantification of lysozyme in jenny milk. *Journal of Food Nutrition and Research* **55** 263–269.
- MIPAAF (2021) Ventunesima revisione dell'elenco dei prodotti agroalimentari tradizionali (GU - Serie Generale n. 48 del 26-2-2021 s. ord n 15). <https://www.politicheagricole.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/16681>. Accessed 19/10/2021.
- Niro S, Fratianni A, Colavita G, Galassi L, Zanazzi M and Salimei E (2021) Technological use of donkey milk in cheesemaking. *International Journal of Dairy Technology* **70** 440–442.
- Ozturkoglu-Budak S, Akal H C, Bereli N, Cimen D and Akgonullu S (2021) Use of antimicrobial proteins of donkey milk as preservative agents in Kashar cheese production. *International Dairy Journal* **120** 105090.
- Ryffel S, Piccinali P and Bütikofer U (2008) Sensory descriptive analysis and consumer acceptability of selected Swiss goat and sheep cheeses. *Small Ruminant Research* **79** 80–86.