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# The influence of goat crossbreeding (Arbia and Saanen) on the cheese yield in Algeria, Djelfa: a preliminary study

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**Abstract** Goat's milk is an excellent source of nutrients because its composition is the closest to that of human milk. This work was concerned with the study of the influence of crosses between local (Arbia) and imported (Saanen) goat breeds raised in the Djelfa region on the yield of fresh cheese made from the milk of two goats. The cheese was made enzymatically using two enzymes of animal origin represented by the coagulating extract of the kaolin layer of chickens as well as bovine rennet, which were applied to goat milk. The obtained results showed that the cross goats cheeses presented better results compared to those of Arbia goats, where we noted cheese yields of 19.52 and 15.41, respectively, for the cheeses of cross goats and Arbia goats coagulated by the layer extract of Kaolin; likewise, the use of rennet confirmed a superiority of the cheese yield of around 17.62 for the product of crossbred goats against 14.45 characterizing that of Arbia goats.

**Keywords:** crossbreeding, goat milk, enzymatic coagulation, kaolin layer, bovine rennet

## 1. Introduction

In some poor regions of the world, the value of the goat is capital because it remains the animal that plays a crucial role in feeding human populations, especially during the great famines that hit the world, particularly on the African continent (Gourine 1989). According to Hafid (2006), the goat has always been part of the human daily life, where it is raised mainly for its milk, meat, and hair; it is called the cow of the poor.

In Algeria, according to Fantazi (2004), goat breeding is one of the most traditional agricultural activities associated with sheep breeding. The goat population remains marginal and represents only 13% of the national herd. The breeding of small ruminants constitutes an important economic activity for the rural human population of the Algerian steppe zones, where the number of goats occupies second place after sheep because of the higher financial income brought by sheep breeding. It ensures interesting meat production compared with goat farming, which provides milk production for self-consumption by the local human population.

Goat's milk is less known and less used than cow's milk, yet it has very important nutritional qualities. Goat's milk is a source of benefits for human health, and it deserves to be consumed more; this milk has the nutritional qualities closest to those of human milk. St-Gelais et al (1999) have shown that its composition, particularly in proteins, lipids, carbohydrates, and essential nutrients, distinguishes it from other species; goat's milk also offers a more incredible richness in minerals and trace elements, especially calcium, phosphorus, potassium, and magnesium. Not only is milk consumed fresh, but it can also undergo various biotransformations that contribute to considering broadening its sensory and nutritional qualities; one of the derivatives of these transformations is cheese (Vignola et al 2002).

In Algeria, as in several other countries of the world, a wide variety of fermented milk products are traditionally prepared whose purpose is the bio-preservation of milk; important traditional Algerian dairy products that have commercial significance are Rayeb, Lben, Klila, Zebda, and Jben (Hamla and Belgourine 2019). According to Daoudi (2006), cheese-making depends mainly on milk and the ferments necessary for its transformation.

The Algerian goat herd is made up of robust breeds that can ensure significant production in very harsh conditions. To improve their milk production, crosses have been made between our local breeds and imported goat breeds characterized by their high milk production and whose most interesting crossbreeding products are crossbreeding products Arbia X Saanen, which represent the most attractive combination because the Arbia goat is the most adapted local breed in Algeria, while the Saanen is considered the best dairy goat in Europe.

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The objective of our work was to study the influence of crosses between goat breeds on the quantity of cheese by making cheeses using two types of milk; for this, the cheese yields of the Arbia X Saanen goat crossed with the Arbia goat were compared.

## 2. Materials and Methods

### *2.1. Selected breeds constituting the goat herd*

Our choice fell on the goat breed characteristic of the Algerian steppe, which is the Arbia breed, and the products of crossing this breed with billy goats of the Saanen breed imported from Europe and introduced to improve the milk production of goats.

### *2.2. Milk sampling*

The milk samples used were mixed milk from 40 healthy females of the same stage of lactation for each of the two goats: Arbia and the crossbred one led in semi-intensive breeding in a steppe zone located in the region of Djelfa in southern Algeria, characterized by a semi-arid climate and steppe vegetation. For each group of goats, we took the same quantity of individual milk (100 ml) to make a representative and homogeneous mixture (i.e., 4 liters). Then, a one-liter sample was used for cheese making. 10 milk samples were taken over a period of one and a half months from the beginning of April in order to work on milk from grazing animals. The milk was collected cleanly; then, the milk samples were stored at 4°C.

According to the survey carried out with the breeders, the animals which constituted our experimental material were vaccinated against brucellosis and were negative for tuberculin, and came from herds free from contagious diseases.

### *2.3. Samples of the Kaolin layer*

The kaolin layer was the horny and wrinkled layer covering the internal face of the chicken gizzard, which was continuously regenerated to reach, according to Subhuti (2005), 3 to 3.5 cm long, 3 cm wide, and 3 mm thick. This diaper was not toxic as it has been used in traditional Chinese medicine, where it has been mentioned as a medicine for stomach diseases.

### *2.4. Bovine rennet*

According to the results obtained by Hamidi et al (2018), the Arbia goat breed showed a very high cheese affinity with the immobilized Kaolin layer used as a coagulant; for this reason, we used purified and freeze-dried bovine rennet prepared in our laboratory diluted to 1% as a second coagulant to evaluate better the effect of crosses on the cheese-making abilities of the goats tested.

### *2.5. Extraction and immobilization of coagulating enzymes*

The enzyme extraction was carried out according to Valles and Furet (1977) method. Powdered gizzard kaolin layer samples of weight P (in g) each were macerated at 42 °C in a volume (V = 5 x P) of a 0.2 M hydrochloric acid solution for 60 minutes. After filtration of each mixture, we obtained crude enzymatic extracts. The latter then underwent clarification by adding 1% (V/V) of a 1 M solution of aluminum sulfate ($AlSO_4$) and 5% (V/V) of a solution of sodium sulfate ($Na_2SO_4$), 1 M heated to 42°C. After a second filtration, we obtained a filtrate to which we subjected a concentration by adding a saturated solution of NaCl to 1% (V/V) of a solution of HCl (d=1.19). After resting for one hour, followed by centrifugation (2100 G/20 min), we obtained a wet precipitate. The pH of these clarified gastric enzymatic extracts was adjusted to 5.5 with a 1 M disodium phosphate solution. They were then stored by refrigeration at 4 °C until use.

For immobilization, we used sodium alginate ($C_6H_7NaO_6$), which preserves the coagulating agent by avoiding protein denaturation after inclusion because this polymer gels at low temperatures in the presence of calcium chloride ($CaCl_2$) solution. According to Hamidi et al (2015), the immobilization of the enzymatic extract in alginate only slightly influenced the coagulant activity because the values of the cheese yields obtained by the extracts of the free and immobilized kaolin layer were comparable; but this treatment offered the advantage of preserving the enzyme after coagulation, which allowed it to be used again, which is of great economic interest.

In order to immobilize the coagulating enzyme, a quantity of 3 g of sodium alginate was dissolved in 100 ml of distilled water, then stirred for 24 hours in order to homogenize the gel. Then a volume of 6 ml of the enzyme was mixed with 100 ml of the sodium alginate solution prepared under agitation for 4 hours to ensure the inclusion of the enzyme in the gel. After preparing a 0.2 mol/l calcium chloride bath, the beads were formed by draining the polymer solution with a syringe into an excess of the prepared solution. Bringing the beads into contact with the $CaCl_2$ solution caused the alginate to gel, thus forming beads that contained the coagulating enzyme. Finally, the balls were soaked in the calcium solution for half an hour.

### *2.6. Milk coagulation*

The milk from each sample from the two groups of goats was divided to make cheeses by the two coagulants used. The milk from each group (500 ml) was added with 0.1 ml of the coagulant and then placed on a heating stirrer at an optimal reaction temperature of 42°C until coagulation; in the case of the kaolin layer, the beads were recovered and rinsed twice with distilled water. According to Hamidi (2015), immobilization made it possible to maintain enzymatic activity after coagulation following the imprisonment of the coagulating agent inside the gel.

*2.7. Cheese yields*

For each coagulant used, we referred to the comparison between the two cheese yields, which corresponded to the cheese weight (in g) actually obtained after draining the milk of the two groups of goats.

*2.8. Statistical analyzes*

Was adopted a two-factor variance analysis represented by the goat breeds and the coagulants used for the preparation of the cheeses; this analysis was attested by an analysis of homogeneous groups using the Newman–Keuls test with $P<0.05$ to highlight the breed whose cheese-making ability was the most interesting.

## 3. Results and discussion

*3.1 Determination of cheese yields*

The coagulation of goat's milk results in the formation of a mass called curd, which contains casein; this curd underwent draining to determine for each preparation the cheese yield representing the number of kilograms of cheese obtained from 100 liters of milk.

After each draining of the coagulums formed, we proceeded to the weighing of the cheeses obtained. The values of the yields are presented in Table 1.

**Table 1** Results of the values of cheese yields obtained.

| Cheese yields | Cheese prepared with bovine rennet | Cheese prepared by Kaolin extract |
|---|---|---|
| Arbia goat cheese | $14.45 \pm 0.34^{a}$ | $15.41 \pm 0.36^{b}$ |
| Cross goat cheese | $17.62 \pm 0.23^{c}$ | $19.52 \pm 0.19^{d}$ |

The different letters (a, b, c and d) show heterogeneous groups.

The cheese yields of the coagulums of goat's milk coagulated by rennet are equal to 17.62 ± 0.23 and 14.45 ± 0.34, respectively, for crossbred goats and Arbia goats. The same observation concerning the importance of yields was recorded for cheeses coagulated by the coagulating extract of the Kaolin layer, where we noted cheese yields of the order of 19.52 ± 0.19 and 15.41 ± 0.36, respectively, for the cross goat and the Arbia goat.

The comparison between the cheese yields from different goats shows the superiority of this parameter in favor of crossbred milk (Arbia X Saanen). According to Grausclaude (1988), the difference is due to the genetic variant for caseins and their frequency, which is more or less important, depending on the animal. The author confirmed that the presence of this variant is not without impact on the cheese-making qualities of the milk.

Examination of the results shows that for each type of milk used, the yield is always higher with the coagulant extract of the Kaolin layer. According to the work of Hamidi (2015), the coagulant extract of the Kaolin layer is characterized by a coagulant activity superior to that of rennet. It can successfully ensure the coagulation of the most difficult milk to coagulate and ensure the production of good quality cheeses.

The analysis of variance showed that the four yields obtained present a significant difference; similarly, the analysis of the homogeneous groups revealed that the cheese yields of the milk of the two goats (Arbia and cross) are different (Table 1), which demonstrates the significant effect of the applied technique (cross) on the cheese-making abilities of goat milk.

The goats that provided the experimental kinds of milk are raised in a single herd under the same breeding conditions (food, habitat, etc.), and the only variable existing is genetic variability. To better assess this variable, we calculated a R coefficient, which represents the ratio between the cheese yield of the crossbred goat on the cheese yield of the Arbia goat characterizing the same coagulant.

The values of the coefficients in Table 2 ($R_{rennet}$ and $R_{CK}$) are greater than 1, indicating the superiority of the cheese-making aptitudes of the crossbred goat compared with that of the Arbia goat.

**Table 2** The calculated values of the R coefficients of the two coagulants used.

| Cheese yields coefficient R | Arbia X Saanen / Arbia $R_{rennet} = 1.07$ | Arbia X Saanen / Arbia $R_{CK} = 1.11$ |
|---|---|---|

According to Bibe and Foulley (1976), a crossbred animal benefits from the heterosis effect (hybrid vigor); the subject's characteristics are superior to those of its parents.

In order to evaluate the effect of coagulants on the production of cheeses for the two experimental animals, we proceeded to the calculations of the C ratios between cheese yield obtained by the Kaolin extract on that obtained by bovine rennet characteristics of the two goat groups. The values of the coefficients in Table 3 ($C_{Arbia}$ and $C_{Arbia\ X\ Saanen}$) are greater than 1 indicator of the superior affinity of the coagulant extract of the Kaolin layer with the milk of the two breeds compared with bovine rennet.

**Table 3** The calculated values of the C ratios of the two experimented goats.

| Coagulants | Kaolin extract / rennet | Kaolin extract / rennet |
|---|---|---|
| Ratio C | C Arbia = 1.22 | C Arbia X Saanen = 1.27 |

Examination of the results shows that the $C_{Arbia\ X\ Saanen}$ ratio and the $R_{CK}$ coefficient are the highest, which confirms that the most captivating combination is that of the goat's milk crossed with the extract of the Kaolin layer as a coagulant, thus affirming the superior affinity of goat's milk crossed with this coagulant.

## 4. Conclusions

The cheese yields of goat's milk coagulated by rennet were 17.62 ± 0.23 and 14.45 ± 0.34, respectively, for crossbred goats and Arbia goats. The higher yields of the order of 19.52 ± 0.19 and 15.41 ± 0.36 were obtained, respectively, for the milk of the crossbred goat and of Arbia coagulated by the Kaolin layer extract. The comparison between the milk yields from different goats announces the superiority of this parameter in favor of milk from crossed goats. Examination of the values of the calculated coefficients and reports shows that the $C_{Arbia\ X\ Saanen}$ ratio and the $R_{CK}$ coefficient are the highest, which confirms the superiority of the cheese-making abilities of crossbred goat's milk compared to that of Arbia goat's milk. The most interesting combination was of the goat's milk crossed with the extract of the Kaolin layer as a coagulant, which confirms the superior affinity of the goat's milk crossed with this coagulant.

## Conflict of Interest

The authors declare no conflicts of interest.

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