Preservation of raw sheep milk: Strategies, consequences, and final impact on dairy products

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Abstract

Sheep milk is mainly produced in small holdings in Brazil and other countries. This milk is commonly used to produce cheese and yogurt. Thus, the use of cold preservation strategies, such as long periods under refrigeration or freezing, is necessary to accumulate the volume of milk compatible with the manufacture of dairy products. This mini-review aims to discuss the impact of these strategies on the microbiological and physicochemical profile of milk and their consequences on dairy products. In addition, the application of physical processes (such as stirring and homogenization) to minimize the negative consequences of cold preservation was discussed. Prevention of protein energy malnutrition among the infants in the developing countries.

Keywords: Sheep milk, Prolonged storage, Freezing, Thawing milk, Microorganisms, Milk stability, Physical processes.

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Introduction

Sheep milk is the fourth most produced milk worldwide [1] and is used mainly for the manufacture of dairy products, due to its high solids content. The favorable production of this milk is a challenge due to the low animal productivity, the seasonality of milk production throughout the year, and the short lactation period [2]. In addition, in many countries, it is produced in smallholdings, which hinders large-scale production [3]. Therefore, for many producers, strategies of long refrigeration or freezing are mandatory to accumulate a volume of milk compatible with the production of yogurt and cheese [3-5].

Freezing Storage

The use of freezing can be an interesting option for the preservation of sheep milk, limiting the growth of microorganisms [4,5]. Previous results have shown no or marginal growth of mesophilic and psychrotrophic microbiota whether the milk is rapidly frozen before storage and rapidly thawed just before processing [5,6]. In addition, reductions were observed in several mastitis pathogens after freezing of milk, probably due to the impact of ice crystals on cell integrity and the increase of osmotic pressure [7]. On the other hand, freezing and thawing times are important concerns regarding the final microbiological quality of milk, since long periods at temperatures that allow the growth of mesophilic and psychrotrophic microorganisms increase their counts, threatening milk safety [2,5]. Therefore, the success of freezing as an alternative to preserve milk depends on the: (i) initial microbiological quality of the milk, (ii) quick reduction of the milk temperature after milking (preferably using a heat exchanger), (iii)fast freezing and thawing processes, which is related to the volume of milk and, (iv) preferably thawing under refrigeration, to minimize the risk of microbial growth [2,5].Freezing impacts the physicochemical parameters of sheep milk due to damage of fat globules caused by ice crystals [8] and alterations in osmotic pressure, with consequent changes in soluble calcium and protein destabilization/ aggregation [5,8]. These alterations result in undesirable changes in milk stability, leading to creaming, increased buffering capacity, and protein precipitation [8]. The intensity of the alterations was correlated with the thawing temperature/ time, being more severe if the milk is thawed under refrigeration (longer time) instead of at room temperature (short time) [8]. In addition, freezing increases the milk acidity, which can be a problem considering that acidity is the main way to indirectly control the sheep milk quality in artisanal production [9].

Long Refrigerated Storage

The preservation of sheep milk using long refrigerated storage is a viable alternative when a few days are enough to accumulate the volume of milk needed for processing [5]. Under refrigeration, most of the microorganism grows slowly, increasing the raw milk shelf life. On the other hand, long storage under refrigeration can stimulate the growth of psychrotrophic microorganisms, which are able to produce thermal resistant proteolytic and lipolytic enzymes. These enzymes can cause yield reduction and defects on dairy products, such as texture alterations and rancid/ bitter flavour [10].The maximum storage time to ensure the milk quality depends on the initial counts of bacteria and the type of microorganisms, storage temperature, cooling rate, and system used for storage of milk (packaged or using a bulk milk cooler) [5,6]. Previous results showed that this time can vary from 2 to

9 days, with longer time observed for the sample stored in the bulk milk cooler due to the faster cooling rate (not static) and lower temperature (4 instead of 7°C) [5]. Regarding to physicochemical alterations, longer refrigeration (4 days at 7°C, a condition that guarantees microbial counts below the safety limit) caused an increase in sedimentation and creaming, possibly due to the activity of agglutinins and proteases from psychrotrophic microorganisms, as well as by the differences in the density and size of the particles governed by the stokes law [8]. In addition, for milk stored during a long time (reaching unacceptable total bacterial counts), measurable changes were observed first in acidity, then in ethanol stability, and finally in pH [5]. This can be explained considering the high buffering capacity of sheep milk, which results in the pH maintenance even with an initial increase of acidity [5,9].

Physical Processes Applied as a Tool to Improve the Stability of Stored Sheep Milk

Physical processes, including stirring (ST), high shear dispersing (HSD), and homogenization at low (LPH, 3.5 MPa) and high pressure (HPH, 50 MPa), were applied after storage of frozen milk to improve the stability of fat and protein [11]. From the results, only HSD was not effective [11], as the process induced the formation of large particles, leading to coalescence and phase separation [12]. The stirring and homogenization processes reduced the fat globules size and favoured casein and fat interactions, reducing creaming and sedimentation in fresh and frozen/thawed sheep milk [11]. The effectiveness of the processes (ST<LPH<HPH) were proportional to their intensity [11]; however, considering the costs of the processes (equipment, operation, and maintenance), stirring is probably the most useful for the artisanal manufacture of dairy products from frozen sheep milk.

Dairy Products made from Cold Stored Sheep Milk

There is no consensus on how much the use of stored raw milk (frozen or long refrigeration) impacts on the quality of dairy products, especially in yogurt and cheese. This is due to the great variety of refrigeration and freezing conditions and different tests carried out on the final products in different works [13]. However, in general, it is stated that the consequences on final products made from frozen sheep milk are less than those observed for frozen cow milk [13]. For cheeses made with frozen sheep milk, it was reported a decrease of the gelation abilities (such as low curd firmness, and higher rennet time), lower fat retention in the curd, and changes in the texture of some cheese (elasticity, graininess and brittleness) [13,14]. In addition, long refrigeration of sheep milk resulted in acid curd and lower yield [15]. For yogurt, raw milk frozen storage resulted in longer fermentation and yogurt with higher sensitivity to post acidification and less firm and adhesive [3,16,17]. Furthermore, milk thawing one day before yogurt production had a positive result, being the yogurt more similar to that produced with fresh milk [3]. The application of physical processes (stirring and homogenization) was able to reduce the separation of the cream during milk fermentation and improves the textural parameters of all yogurts [16]. However, these improvements were not sufficient to guarantee similar sensory acceptance for yogurt produced from frozen milk compared to fresh milk, probably due to the lower perception of creaminess. Finally, longer refrigeration results in minor changes in yogurt, mainly affecting the fermentation process (longer) but not the physicochemical and sensory characteristics of the final product [17].

Conclusion

The preservation of sheep milk under refrigeration (few days) or freezing are viable alternatives for artisanal producers to accumulate a volume of milk compatible with cheese/ yogurt production. Comparing these two alternatives, refrigeration is the best option when a few days are sufficient to reach the desired volume of milk, since it causes less changes in the physicochemical and microstructural characteristics of milk and manufactured products. Freezing is the only option when prolonged storage is necessary, but it affects saline balance, fat integrity, and protein stability. These alterations can reduce the yield, stability and overall quality of dairy products. To minimize the negative impact of freezing, stirring or homogenization processes can be used to improve the stability of the milk after thawing.

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