Methods of processing Camel Milk into Cheese

SUMMARY:

Cheese-making technology aims to preserve milk so that consumption can be postponed for periods from a few days to several months. The preservation of the product is obtained mainly through lactic acidification and limited dehydration. These operations take place during the two first steps of processing, the setting (or coagulation) and draining phases. For many cheese types, a third phase known as ripening then takes place. This induces changes in the coagulum, separated during draining, caused by complex microbial and enzyme reactions.

KEYWORDS:

Camel milk [1]
Camels [2]
Milk fat [3]
Milk byproducts [4]
Desert climate [5]
Cheesemaking [6]
Cheese whey [7]
Cheese [8]

CATEGORY:

Livestock production [9]
Nutrition for better life [10]

COUNTRIES:

Algeria
Egypt
Libya
Morocco
Saudi Arabia
Sudan
Tunisia

DESCRIPTION:

Introduction

Existing data on the milk yield of camels are numerous but highly variable. According to results from several authors, lactation periods vary from 9 to 18 months, with annual milk yields of between 800 and 3600 litres. Mean daily milk production is reported to range from 2 to 6 litres under desert conditions and up to 12 to 20 litres under more intensive breeding systems. These large differences can be explained by the fact that measurements have often been made under local conditions without taking into account local factors that might influence milk production. Furthermore, camel breeds or individual animals probably exist with significantly different milk-producing potential that has not been fully exploited because the selective pressure of humans on the camel has been minimal compared with other domestic animals (Richard and Gérard, 1989).
Nutritional factors also influence milk production. Diets enriched with green forages such as alfalfa, bersim or cabbage greatly increase milk yield (Knoess, 1977; Knoess et al., 1986; Richard and Gérard, 1989). The amount of milk is only marginally decreased when drinking-water is restricted, while total solids are significantly lowered (Yagil and Etzion, 1980; Yagil, Saran and Etzion, 1984; Ramet, 1987; Farah, 1993). This milk dilution is a physiological response to heat and could be a natural adaptation to provide much-needed water to the dehydrated calf (Yagil, Saran and Etzion, 1984; Farah, 1993).

Studies concerning the development of milk quantity as a function of stage of lactation indicate little correlation. Lactation curves in fact indicate large differences compared with other lactating mammals. Some curves indicate low yields during the first half of the lactation period and an increase in the second. Other results report higher yields at the beginning, followed by falls towards the end. Occasionally, one or two distinct peaks can be observed or, conversely, steady production throughout the lactation (Field, 1979; Bachmann and Schulthess, 1987; Ellouze and Kamoun, 1989; Richard and Gérard, 1989; Martinez, 1989). The high disparity between these various sets of data can probably be explained by differences in genetic potential, climate, feeding conditions and sampling techniques.

Milking practice also affects the amount of milk. Generally, the calf is allowed to suckle for a few minutes before hand milking. The actual volume of milk secreted is therefore difficult to measure. If milking is performed without any previous mechanical stimulation of the mammary gland, lower yields are observed. Milking must be done by a person who is well known to the camel. When the usual milker is changed, significant milk retention is often observed. It also appears that milking frequency influences daily milk yield. Generally, animals are milked two to four times a day (Hartley, 1980; Ramet, 1987; Martinez, 1989; Abeiderrahmane, 1994) but sometimes as many as six or seven times (Knoess, 1977). Changing the milking frequency from two to four operations increased milk production from one to 1.5 litres a day (Evans and Powys, 1980).

**Processing stages**

**Coagulation**

Milk clotting coincides with the destabilization of the original micellar state of milk casein. In practice, destabilization is effected by two methods:

- by enzymic action, using milk-clotting enzymes such as rennet;
- by fermentation, using endogenous lactic acid bacteria and/or inoculated lactic starters.

The mechanisms of the clotting methods are completely different but both lead to the formation of a coagulum called a curd or clot. The physical and rheological properties of the curd depend on the clotting method used (Table 9).

In typical cheese making, the two methods are never used separately but the balance of each is well defined for a particular cheese variety. The different cheese categories can be identified on this basis as follows:

- fresh cheeses processed mainly with lactic clotting;
- semi-hard and hard cheeses processed mainly by enzymic clotting;
- soft cheeses processed by balancing the two methods.

**Draining**

The fresh coagulum is physically unstable, which leads to a progressive and spontaneous separation of the curd and whey. This development is characterized by segregation of the different components of the milk solids. Most of the water and lactose and a small fraction of the fat and protein accumulate in the whey.
Most of the protein and fat are progressively concentrated into the cheese curd according to the method used to drain the whey.

In addition to its clotting effect, the acidification process plays a key role in eliminating the colloidal minerals of the casein micelles. The final solubility level of calcium and phosphorus determines the draining rate of the curd and, in turn, the texture and total solids content of the cheese.

The processing parameters for each type of cheese aim to develop the curd and, at the same time, an acidity profile which induces a specific acidity level and physical-chemical composition. Typical acidity development profiles must be followed during the draining process in order to produce different varieties successfully. This includes the need to know the strength of the lactic acid bacteria and to understand and control the development of lactic starters.

Ripening

At the end of draining, the composition, volume and shape of the curd are well defined. At this stage, most cheese varieties are placed in ripening rooms. The purpose of this final processing phase is to modify and improve the appearance, composition, texture, flavour and nutritive value of the cheese.

From a chemical standpoint, ripening corresponds to an enzymic development of the curd in which proteolysis and lipolysis are mainly dominant. Casein is hydrolysed during ripening into fractions of low molecular weight: polypeptides, peptides, amino acids and ammonia. The fat is less modified in the majority of cheeses but, conversely, more hydrolysed in some blue types of soft cheeses. As a result, fatty acids, glycerol, aldehydes and ketones are liberated and accumulated in each type of cheese according to a typical profile.

Proteolysis and lipolysis are caused by numerous enzymes of various origin: endogenous milk enzymes, the residual activity of milk clotting enzymes, microbial enzymes produced by moulds and bacteria and yeasts growing into or on the surface of the cheese. This last category is dominant in cheese varieties ripened by these microflora. For cheese without external or internal flora, hydrolysis is much lower.

The optimum pH for the enzymes is generally near neutral (pH 7.0). At the end of draining, the cheese pH, around 4.5 to 5.2 depending on the variety, is too low and unsuitable for optimal development. It is thus necessary in practice to increase the pH, which may be done as follows:

- for semi-hard and hard cheeses, neutralization occurs as a result of the large amount of minerals remaining in the curd;
- for soft cheeses and some semi-hard cheeses, the pH increase is effected by specific microflora that assimilate lactic acid.

The cheese ripening processes are complicated and specific to each cheese variety. From a practical standpoint, several factors such as regulation of room climate (temperature, humidity, air flow), time and handling (turning and cleaning) are used to obtain a standard product in accordance with the required composition and taste characteristics.

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Basic milk-processing parameters

To achieve a good-quality product, the following recommendations should be followed:

- select milk with good chemical and microbial quality;
- make the cheese in a clean, dust-free environment;
use properly cleaned and disinfected utensils;
employ healthy, clean, trained staff;
enhance the processing capability of camel milk by corrective treatment such as heating and/or adding solids and calcium salt (see Milk preparation on p. 18);
systematically check the main processing factors controlling production;
use only additives (lactic starters, milk-clotting enzymes, salts, etc.) of food-grade standard with good chemical, microbial and technical properties;
store heat-sensitive additives under refrigeration to limit activity loss;
keep perishable raw materials and manufactured products under cool conditions and protected from light, dust and rodents;
reject defective or questionable raw materials and products.

Preparing and using lactic starters

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Using the right lactic starter ensures authentic taste and hygienic quality. For cheese made from raw milk, lactic starter addition is recommended to boost the natural population of lactic acid bacteria and inhibit harmful flora such as coliforms and psychrotrophic and pathogenic bacteria. For cheese made from heat-treated milk, lactic starter addition is mandatory to develop proper acidity, drainage and acid preservation of the curd.

Lactic starters can be prepared by simple methods adapted either for household or for industrial production. The recommended method of preparation is as follows:

- select the growth medium, which can be either fresh milk with good bacteriological and chemical quality or reconstituted milk obtained from dissolving 10 percent skimmed milk powder in potable water;
- pour the reconstituted milk into containers for sterilization;
- sterilize the milk at 100 to 120°C for ten to 20 minutes;
- cool down to the incubating temperature;
- inoculate the milk under aseptic conditions with the mother culture at the rate of either 0.5 g of dry culture per 0.5 to 1 litre, or 20 ml of liquid culture per 0.5 to 1 litre;
- incubate in an incubator or at room temperature: mesophilic starters at 25 to 35°C for eight to 12 hours, thermophilic starters at 42 to 45°C for two to four hours;
- halt incubation when the acidity reaches 0.7 to 0.9 percent lactic acid or pH 5.0 to 5.5;
- cool down and keep the starters under refrigerated conditions (0 to 4°C) until used;
- avoid long storage periods, which reduce lactic acid bacteria viability;
- keep the mother cultures at deep freezer temperatures (-40 to -80°C).

Adding cheese-ripening moulds

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Some types of cheese are traditionally ripened with moulds that develop either on the surface (fresh, soft and some semi-hard cheeses) or in the body of the cheese (blue cheeses). Traditionally, the uptake of moulds occurs through natural inoculation when the cheese is left out in the ripening room, which is full of spores. This method is risky, however, and causes inconsistency in appearance and taste of the cheese. It is better to use a more controlled inoculation of commercially available complementary exogenous cultures, obtainable in dried or liquid form.

The dominant organisms in the surface flora are strains of Penicillium, Geotrichum and, occasionally, Mucor. These moulds are often also associated with yeasts and bacteria. Penicillium camemberti is widely used and gives a typical white appearance to many soft cheeses, such as Camembert or Brie, and to some semi-hard cheese such as White Tomme. Penicillium roqueforti is the typical mould that develops in blue cheeses, growing in the holes in the cheese curd.
Inoculation of spores is carried out by two methods:

- in the milk prior to coagulation by mixing an appropriate quantity of commercial strains;
- on the surface of the salted cheese, either by soaking in a solution of spores in sterile water or by spraying the solution over the whole surface.

Equipment used for inoculation must be thoroughly cleaned and disinfected to avoid contamination by spoilage organisms. The spore concentration is adjusted according to the method given by the manufacturers.

Because the moulds used in cheese ripening are highly aerobic, the cheese is placed on trays or wooden boards, which allow good all-round surface aeration. During ripening, the cheese is regularly turned to ensure even growth of the mycelium. Other environmental factors also need to be closely regulated to optimize mould development. The temperature is usually set between 12 and 14°C, except for blue cheese when it is set at 6 to 7°C. The relative humidity is set between 85 to 95 percent, depending on the sensitivity of the microflora to water activity. Under these conditions, mould growth is quite slow. The mycelium becomes visible after four to six days; full development takes up to 15 to 25 days.

The proteolytic and lipolytic potential of mould enzymes is important and influences significant biochemical changes in the composition and taste of the cheese.

**Characterizing and using milk-clotting preparations**

The activity of commercially available milk clotting preparations is determined in cheese making by clotting strength, which corresponds to the ratio between a defined amount of the preparation (volume for liquid preparations, weight for dried preparations) and a defined amount of milk to be clotted under precise time-temperature conditions. The standard reference used in Europe indicates that 1 kg of powdered rennet, labelled with a strength of 1/150 000, will coagulate 150 000 litres of milk at 35°C within 40 minutes.

The strength of liquid preparations declines slowly at ambient temperature (15 to 45°C) and refrigerated storage (0 to 6°C) is recommended. Dried preparations are less sensitive, but refrigeration is advisable for prolonged periods of storage.

The clotting enzyme quantities indicated in the following summaries for processing camel milk into cheese are given with reference to enzyme preparations with a strength of 1/100 000. When preparations with different strengths are used, the amount should be corrected according to the strength ratio.

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