# MANUFACTURED DAIRY GOAT PRODUCTS


Goat milk products, St. Helen Farm, York, England

## 1. CHEESE

## MANUFACTURING TECHNOLOGY OF GOAT MILK CHEESES:

**(Reference contents were adapted from: Park, Y.W. and M. R. Guo. 2006. Goat Milk Products: Processing Technology, Types and Consumption Trends. In: Handbook of Milk of Non-Bovine Mammals. Y.W. Park and G.F.W. Haenlein, eds. Blackwell Publishers. Ames, Iowa and Oxford, England. Pp. 71-92).**

### 1) Preparation of goat milk for cheese manufacture:

Since a good cheese is only made from good quality milk, good cheese making milk must be quality milk, and must meet the following criteria; (i) It must be free of any visible impurity, (ii) It must not present any abnormal taste or order, (iii) Its acidity must be in the vicinity or only slightly higher than at milking time, unless it has been subject to a ripening period in which the lactic acid producing bacteria have been allowed a period of time to acidify the milk, (iv) The naturally occurring lactic acid producing bacteria and or yeasts or the cheese starter culture bacteria which can be

added to the milk must be able to survive and reproduce to the proper numbers in the milk, (v) The milk must contain no foreign substances such as antibiotics, antiseptics, cleaning products, etc., and (vi) The milk must not be contaminated by either pathogenic microorganisms or by microorganisms which may prove undesirable for the production of cheese.

## 2) Processing methods and procedures of goat milk cheeses:

### a) Soft goat milk cheeses:

The traditional farmstead goat milk cheesemaking consists of the following nine basic steps: (a) filtering of the milk, (b) Renneting, sometimes preceded by acidification, (c) Coagulation of the milk, (d) Placing of the curds into cheese moulds, sometimes preceded by pre-draining, (e) Draining, sometimes interrupted by turning the cheeses over, (f) Unmoulding, (g) Salting, (h) Drying, and (i) Ripening. These procedures are traditionally used for French soft body type farmstead goat cheese manufacture.

There are also some large scale commercial goat milk cheese processing plants in France. These caprine cheeses produced in large scale commercial production such as in the Poitou-Charentes, Poitiers region, are intended for exports to other countries. Although the basic cheesemaking procedures are similar for many goat cheese producing countries, numerous different varieties of caprine cheeses can be made due to the variation in the composition of milk, modifications of manufacturing procedures, and multitude of aging time and conditions.

Even licensed commercial goat dairy may modify the pasteurization procedure due to unaffordability of installation of steam and chill water systems. One example is a licensed grade A goat dairy located in a southern state of the U.S., which has the following modified procedures for soft goat cheese manufacture: Goat milk is pasteurized at 62.8$^{o}$C (145$^{o}$F) for 120 minutes and by slow coagulation and natural draining, then hanging the cheese in cheesecloth for three days in a cool room (22$^{o}$C) before packaging. The cheeses are packaged in 454g rod shapes with polyolefin shrink wrap, then delivered to local consumers or shipped for other locations.

### b) Semi-hard and hard goat cheese processing technology:

Semi-hard or hard goat milk cheese varieties such as Monterey Jack, Gouda, Cheddar, blue, Camembert cheeses can be manufactured. In the U.S., a significant volume of Monterey Jack goat cheese is commercially produced and marketed.

Manufacturing procedures of Monterey Jack goat milk cheese routinely performed at the University dairy processing pilot plant of the Georgia Small Ruminant Research and Extension Center (GSRREC), Fort Valley State University, GA, U.S.A., is described as the following detailed protocol: The bulk milk from its mixed herd of Nubian, Saanen, and Alpine goats is transferred to the vat pasteurizer. The milk is pasteurized at 62.8°C (145$^{o}$F) for 30 min. The cheese is manufactured according to the modified procedure of well documented processing methods . Each batch of cheese is made using between 135 and 170 L of milk maintained at 88°F (31°C) in a 60 gallon (227 L) cheese vat. Lyophilized mesophilic direct vat set starter culture (R704, 50 units, Chr. Hansen, Inc., Milwaukee, WI) and 18 ml of single strength rennet (Chymax; Chr. Hansen, Inc., Milwaukee, WI) are added to the milk

and then allowed to coagulate. The curds are cut using 1.6 cm wire knives and allowed to heal for 5 minutes. The temperature is gradually raised to 39°C (102°F) over 30 minutes and the curds are cooked until firm for about 45 to 60 minutes. Two-third of the whey is drained and warm water (31°C) is added to the vat to wash the curds and to bring the temperature of the whey to 88°F (31°C). The curds are soaked with the water for 5 minutes before the whey is completely drained. Curds are placed into 6 x 6 inch (15.24 x 15.24 cm) Wilson hoofs and pressed at 40 psi overnight at room temperature in a vertical cheese press (Pneumatic Press, Kusel Equip. Co., Watertown, WI). Cheeses are removed from the molds, cut into disks 5.08 cm (2 inches) in height, and vacuum packed in plastic pouches (FreshPak 500 vacuum pouches, Koch Supply, Kansas City, MO) using a vacuum packager (Koch Ultravac 250, Koch Supply, Kansas City, MO), and stored at 4°C in a walk-in-cooler for 6 weeks before marketing.

## 2. YOGURT

### 1) General characteristics of goat milk yogurt

Goat milk yogurt was one of the traditional products from countries where fermented dairy foods originated. Fermented goat milk products played a significant role in securing food for rural communities of many developing countries. There is a target market of goat yogurt for individuals who look for the special taste or health benefits, who are allergic to cow milk protein, specifically $\alpha_{s1}$-casein. Some individuals who simply enjoy the flavor of goat milk products, in fact many gourmet food consumers are willing to pay high prices for certain goat milk products. In addition, certain consumers believe that goat milk is nutritionally superior to bovine milk. This belief certainly creates a larger market. Fermentation diminishes the "goaty" flavor, which is so often perceived as distasteful in the US market. This taste is attributed to the aroma compounds and acids produced by the yogurt starter cultures during fermentation. Goat milk yogurt can be made in a similar manner to the cow counterpart. One of the main problems in manufacture of goat milk yogurt is weak and lack of consistency in curd tension or viscosity upon agitation compared with cow yogurt. This is due to the difference in protein composition between the two milks, especially in casein contents.

### 2) Manufacturing procedures of goat milk yogurt:

There are different yogurt products throughout the world, using different yogurt cultures and varied milk composition. The typical manufacturing steps are shown in Figure 1 and Table 1. The basic processing procedures of goat milk yogurt include: (i) Preparation of milk, (ii) Standardization (standardized to 1.0-1.7% fat), (iii) Pasteurization (72°C for 20 sec, or cow yogurt 90.6°C for 40-60 sec. (HTST) or 85°C for 30 min. (vat)), (iv) Cool the pasteurized mix to 116°F (46.7°C) and hold in vat for up to 15 min, (v) Inoculation (45°C) (Carefully introduce into warm milk or milk mixes 1.25% by weight of active *Lactobacillus bulgaricus* culture and 1.25% *Streptococcus thermophilus* culture), (vi) Packaging (set yogurt), (vii) Incubation (Permit filled

containers to remain in room at 114°F (45°C) for 3-5 hrs. or until a firm, smooth gel has formed to pH 4.5), (viii) Chilling (Yogurt is chilled to 45°F (7.2°C) in less than 1 hr), and (ix) Storage and distribution (Store the containers of yogurt at 40°F (4.4°C) or lower; The shelf life at this temperature is 30-60 days).

Commercial goat milk yogurt, York, England

Table 1. Manufacturing Conditions and Procedures of Cultured Goat Milk Products[a]

| Products | Milk Type | Culture Microorganism | Type of Inoculum | Rate of Inocula-tion (%) | Incubation Temp. °F(°C) | Incubation Time (Hr) | Stop Incubation at pH | Stop Incubation at %TA |
|---|---|---|---|---|---|---|---|---|
| Buttermilk | | | | | | | | |
| | Skim or Low fat | S. lactis<br>S. cremoris<br>L. citrovorum<br>S. diacetilactis | Bulk start or direct set | 0.5-1.0 as directed | 72 (22)<br>72 (22) | 14-16<br>12-16 | 4.5<br>4.5 | 0.8<br>0.8 |
| Acidophilus | | | | | | | | |
| | Skim or Low fat | L. acidophilus | Bulk start | 0.5 | 100-111 (37-44) | 18-24 | 3.8 | 1.0 |
| Sour Dip | Half-n-Half (11% fat) | Same as for buttermilk* | Bulk start or direct set* | 1.0 | 72 (22)* | 14-16 | 4.8* | 0.7* |
| Kefir | Whole | S. kefir<br>T. kefir<br>L. caucasicus<br>S. lactis | Kefir grains | As directed | 72 (22) followed by 50 (10) | 12<br>24-72 | 4.5 | 0.8 |
| Yogurt | Skim or Low fat | S. thermophilus<br>L. bulgaricus | Individual cultures or direct set | 1.25 each or as directed | 114 (45.6) | 5-6 | 4.2 | 0.9 |

*Same conditions for sour dip and sour cream; sourcream as 18% fat.
[a]Data from Loewenstein et al. (1984), Kosikowski (1977), and Park and Guo (2006).

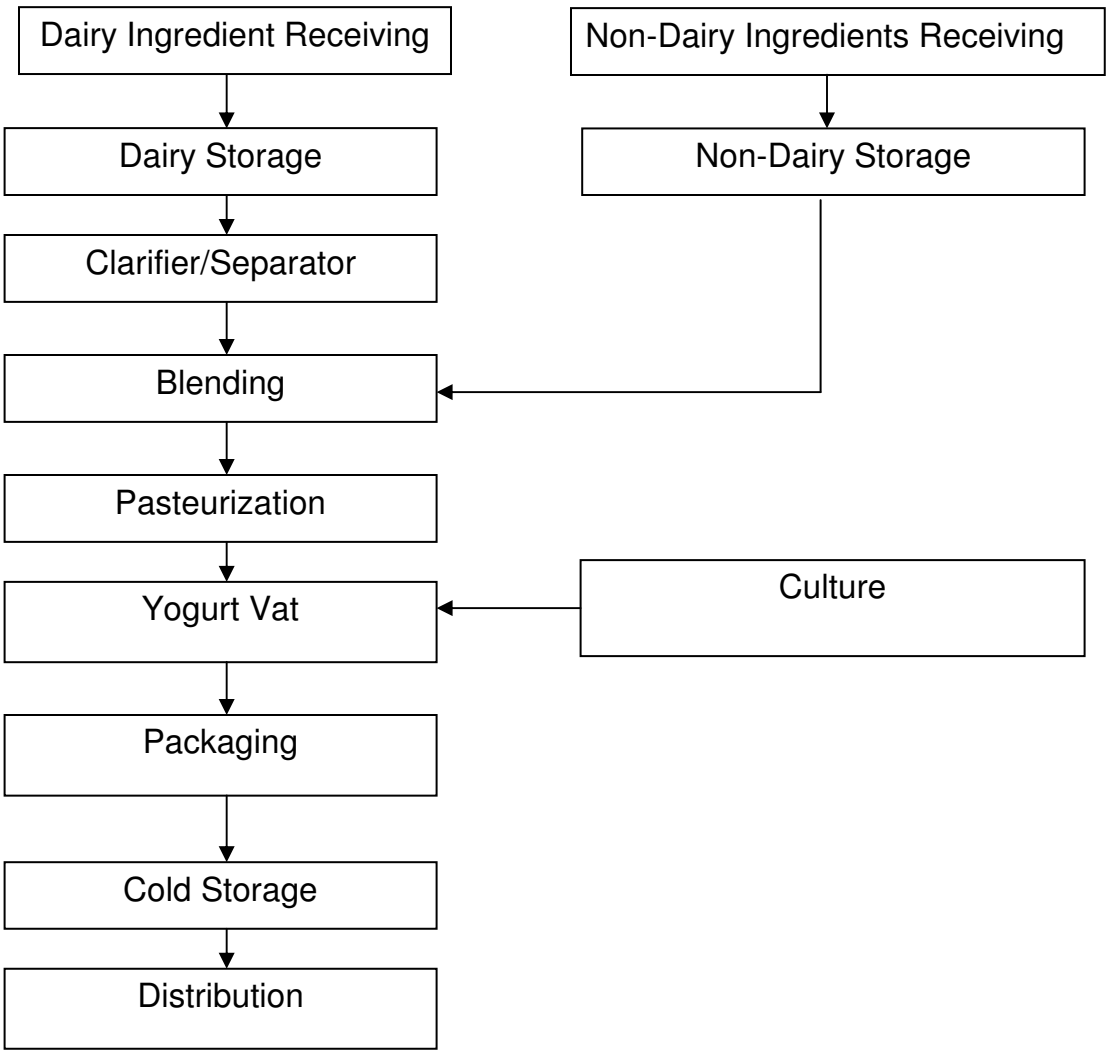


Figure 1. Flowchart for manufacture of yogurt.

## 3. OTHER GOAT MILK PRODUCTS AND THEIR PROCESSING TECHNOLOGIES:

There are many other fermented goat milk products produced and consumed, including buttermilk, acidophilus, sour dip and kefir. The manufacturing procedures of these other important fermented goat milk products are summarized in Table 1. Different culture microorganisms are used for these different types of fermented milk products, and incubation is stopped at different desired acidity as shown in Table 1.

### 1) Buttermilk

Buttermilk is usually made from skim milk using the by-product from churning butter out of sour cream. Goat buttermilk is made from skim milk (less than 0.5% fat); yogurt made from whole milk (3.25% fat ), low fat milk (0.5 to 2.5% fat), or skim milk; sour cream must contain 18% fat in most states. Sour dip is made from half-n-half milk (11% fat) using the same kind of culture organisms used for buttermilk manufacture.

## 2) Acidophilus milk

Acidophilus milk can be made by the activity of Lactobacillus acidophilus, which is capable of converting a greater proportion of the lactose to lactic acid (2%). It is pasteurized milk or low-fat milk inoculated with *Lactobacillus acidophilus*, which destroys other competing bacteria antagonistic to man in the lower intestine. These organisms have the ability to implant themselves in the large intestines, survive the low surface tension and change nutrients. In the past the popularity of this product was limited by the flavor developed during fermentation. A more recent product has overcome this by adding the live organisms to pasteurized milk and refrigerating to prevent subsequent fermentation and flavor development. In manufacture as shown in Table 11, skim milk or partially defatted milk is sterilized in an autoclave at 120$^{o}$C for 20 min (15 psi), then tempered to 38$^{o}$C. Next, a 5% inoculation of active L. acidophilus starter is introduced. The mixture is incubated at 38$^{o}$C for 18 to 24 hr until a curd forms with about 1.0% titratable acidity.

## 3) Kefir

Kefir is an acidic, slightly foamy product, made from pasteurized and fat-standardized or decreamed goat milk, which has passed through a combined acidic and alcoholic fermentation of symbiotic lactic acid bacteria and yeast “kefir grains”. The finished product, kefir contains 0.6-0.8% lactic acid, 0.5-1.0% alcohol and carbon dioxide. The dominant microbial flora of Kefir consists of *Saccharomyces kefir, Torula kefir, Latobacillus caucasicus, Leuconostoc spp*. and lactic acid streptococci. Yeasts represent 5 to 10 % of the microbial population.

## 4) Ghee and butter-like products

Ghee is an Indian (and Middle East) clarified butterfat product which is manufactured by fermenting whole milk into curd and churning out butter, followed by heat clarification at 105-145$^{o}$C. In the Middle East, casein is produced from skimmed milk. In Iran it is called *Kashk* or dried butter. It is used as food ingredient or in the form of meal as animal feed. In India, Chhana, Khoa and Paneer (a cheese) are also made from goat milk. Chhana is an acid- and heat-coagulated milk product.

## 5) Sour Cream

It is fresh pasteurized cream mildly coagulated with lactic acid culture plus

*Leuconostoc* flavor bacteria. It is higher in fat and heavier in consistency than cultured buttermilk. Cultured or sour cream is an acid gel of delicate flavor resulting from the growth and activity of lactic streptococci and flavor-producing *leuconostoc* bacteria in light cream.

### 6) Half and Half Sour Cream

It resembles sour cream but has a butterfat content of 10 percent rather than the usual 18%. It is less viscous and is inclined to whey-off. The fermentation and manufacture patterns are those of regular sour cream.

### 7) Koumiss

It is another unique lactic-alcohol fermented milk of considerable commercial and public health significance to Russia. It is usually made from mare's milk, and approximately 230,000 horses had been maintained in Russia specifically for the production of Koumiss. The name is derived from the Kumanes, who survived until 1235 as Kumane river tribe on the central Asian steppes. The production of this fermented milk was continued by Tartars and Kalmuds, famous horse breeders and nomads of Asiatic Russia. In 1971, Russia produced approximately 2.5 billion lbs Kefir, 1.5 billion lbs sour cream, 0.5 billion lbs yogurt, 400 million lbs cultured milk, and 50 million lbs of *Lactic bulgaricus* milk. Koumiss is a milky white liquid with a greyish cast. It is not watery but possesses a uniform consistency without any tendency to flake or to whey-off. This fermented milk more closely approaches the characteristics and composition of human milk than cow milk. Mare's milk forms no visible curd, and contains five times more vitamin C than cow's milk. The fermentation of mare's milk to Koumiss is carried out by *L. bulgaricus* and Torula yeast. Lactic acid, ethyl alcohol, and carbon dioxide are the resulting end products and impart to Koumiss a characteristic sourish flavor. Like Kefir, it fizzes and bubbles on shaking. In Russia, Koumiss is widely used for treating pulmonary tuberculosis and has apparent therapeutic values.

Koumiss fermentation in urn. (Photo by Heping Zhang).

## 8) Sweets from goat milk

Sweet products made of goat milk are so pupular in Mexico, Norway and India. In Mexico, the *Caheta* a thick liquid of caramelized milk with sugar added, which is popular and sold as such or dried as small tarts. In Latin American countries, other sweet made of goat milk called, "*dulces*" are produced in similar way. In Norway, *gjetost*, brown sugar cheese, is produced, which is similar to *Cajeta*. *Gjetost* is a sweet caramel-colored product with a texture in which lactose crystals may be often noted. The processing of *geitost* is simliar to the *Cajeta* except that the casein is removed while the original lactose is used instead of sugar. In India, a chhana-based sweet is made by kneading chhana and cooking in sugar syrup over medium heat. Khoa is a heat-desiccated indigenous milk product used in the preparation of a variety of sweets.


Mexico goat milk *Caheta* and other sweet products, Celaya, Mexico

## 9) Evaporated and powdered goat milk products:

Evaporated and powdered goat milk products are manufactured in U.S. and New Zealand, marketed around the world, but very little research data and reports are available

on these products. Significant quantity of powdered goat milk is commercially produced especially in the USA and New Zealand. Evaporation is usually done under reduced pressure, primarily to allow boiling at a lower temperature and thus prevent damage due to heating.

The principal components of an evaporation plant are: (a) Evaporation chambers operating as heat exchangers, (b) Equipment for the production and maintenance of a vacuum, (c) Separators for the separation of vapor and concentrate, and (d) A condenser for the vapor. The basic principles of the evaporation system are based on the fact that steam or vapor is condensed on one side of a metal surface in the heat exchangers, causing the liquid on the other side to evolve vapor. Evaporated goat milk would be processed using the similar evaporation facilites as performed for evaporated cow milk products. General composition of evaporated cow milk has 7.5-9.0% fat, 17.5-22% milk solids nonfat, and 25-31% total solids.

For powdered milk, there are two different methods of manufacture of dried milk products; roller drying and spray drying process. In the roller drying process, milk or milk concentrate is applied in a thin film on the surface of a rotating, steam-heated metal drum. During the rotation the milk film dries and is continuously scraped off by a stationary knife located opposite the point of application of the concentrate. The spray drying process involves the transformation of fluid state into a dried particulate for by spraying the milk into a hot drying medium. Four process stages of conventional spray drying include: (i) Atomization of milk into a spray, (ii) Spray drying air contact (mixing and flow), (iii) Drying of spray (water evaporation), (iv) Separation of dried product from the air.

Powdered products, including whole milk, skim milk, whey, cream, ice cream mix, protein concentrates, infant foods, are produced by several methods of drying liquid such as spray drying, drum drying, and freeze drying, etc.

## 10) Frozen goat milk products:

Ice cream was manufactured from goat milk in Georgia and Texas. However, only research data from the University of Georgia, Athens, GA and Fort Valley State University, Fort Valley, GA, USA have been reported. The three formulations made for three flavors of goat ice cream were: i) French vanilla mix with 14% fat, 10% MSNF, 18% sweetener (12% sucrose, 6% 36-dextrose equivalent corn syrup solids), 1.4% egg yolk solids, and 0.25% stabilizer-emulsifier; ii) Chocolate mix: 14.6% fat (0.6% cocoa fat), 9% MSNF, 20% sweetener (14% sucrose, 6% 36-DE corn syrup solids), 3% medium fat cocoa, and 0.22% stabilizer-emulsifier; iii) Premium white mix: 15% fat, 10% MSNF, 18% sweetener and 0.25% stabilizer-emulsifier.

Recently, the dairy technology research group at Fort Valley State University conducted scientific studies on nutritional, textural and sensory qualities of goat milk ice creams, using skim milk, 2% fat milk and whole goat milk and commercial ice cream mix. Upon pasteurization, one gallon of each type of milk was thoroughly mixed with 3 pounds of a commercial ice cream mix. The mixtures of 3 types of milk and mix were poured into 2

separate tanks in an ice cream machine, and agitated and frozen to make soft serve ice cream, and then stored at -18$^{o}$C.

Soft serve vanilla goat milk ice cream, Fort Valley State University, Fort Valley, GA, USA.

## 8) Cosmetic goat milk products:

Recently cosmetic products made from goat milk such as goat milk soap, hand lotion, etc., have been increasingly popular. These products are commercially produced in the U.S. and other countries like Switzerland. An internet search on goat milk soap shows a list of more than 5,000 references. The number of home-based goat milk soap businesses has been tremendously increased in recent years, and now estimated to generate multi-billion dollars of annual revenues in the U.S. Ingredients required for home-made style goat milk soapmaking include: lye, goat milk, borax, oatmeal, and pork lard or vegetable oil, etc.

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