Specialty products made from goat milk

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\textbf{Article history:}
Available online 25 January 2010

\textbf{Keywords:}
Goat milk
Specialty products
Cheese
Yogurt
Ice cream
Powder milk
Sweets
Cosmetics

\textbf{Abstract}
Although it may not be important in certain parts of the world, the contribution of goat milk to the economic and nutritional wellbeing of humanity is undeniable in many developing countries, especially in the Mediterranean, Middle East, Eastern Europe and South American countries. Goat milk has played a very important role in health and nutrition of young and elderly. Goat milk has also been known for its beneficial and therapeutic effects on the people who have cow milk allergy. These nutritional, health and therapeutic benefits enlighten the potentials and values of goat milk and its specialty products. The chemical characteristics of goat milk can be used to manufacture a wide variety of products, including fluid beverage products (low fat, fortified, or flavored) and UHT (ultra high temperature) milk, fermented products such as cheese, buttermilk or yogurt, frozen products such as ice cream or frozen yogurt, butter, condensed/dried products, sweets and candies. In addition, other specialty products such as hair, skin care and cosmetic products made from goat milk recently have gained a further attention. Nevertheless, high quality products can only be produced from good quality goat milk. The quality milk should have the potential to tolerate technological treatment and be transformed into a product that satisfies the expectations of consumers, in terms of nutritional, hygienic and sensory attributes. Taste is the main criteria used by consumers to make decisions to purchase and consume goat milk and its products. Typical goat taste is considered as a quality component in certain goat cheese products. Farmers can produce more value-added products for the economic sustainability of their business and the dairy goat industry in general.

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1. Introduction

The use of goat milk as an excellent food source is undeniable. It has beneficial effects for health maintenance, physiological functions, in the nutrition of children and elderly people, and according to some authors, can be consumed without negative effects by people suffering cow milk allergy. This highlights the market potential of goat milk.

Goat milk should have a mild, neutral and appealing flavor. Park (2005) stated that the most important quality standard for goat milk is an acceptable, attractive odor and taste. According to Mowlem (2005), goats have had very bad publicity for many years and as a result considerable prejudice against goat products sold in the United Kingdom (UK). He stated that the milk would be described by almost everyone who was not a goat enthusiast as “strong, smelly, salty or sweet”. With such a reputation it was almost impossible to persuade anyone to try goat milk, even if offered at no cost. Unfortunately, this is true in many regions around the world. Park (2005) added to this by stating that the two biggest barriers in marketing goat milk...
are negative public perception of “goat like” flavor and seasonal milk production. The origin of this misconception can be traced to the fact that goat milk is sometimes obtained in poor sanitary conditions and that goat milk products are poorly manufactured. Only a widespread teaching of goat milk benefits and good taste can transpose this poor reputation.

Quality of goat milk can be defined as the milk’s potential to tolerate technological treatment and become a product that satisfies the expectations of consumers, in health terms, nutritional value, security (hygiene) and pleasure (sensory attributes). The concept of quality has recently evolved considerably. Animal welfare, the farm environment and the general organization of production is now being considered to a greater extent (Pirisi et al., 2007).

Fat is one of the most important components of fluid goat milk, and lipids are involved in cheese yield, firmness, color and flavor of goat dairy products. Various fatty acids are also potentially involved as positive or negative predisposing factors in the health of human consumers.

Goat milk production is likely to be much greater than in official statistics, mainly because of the large amount of unreported home consumption, especially in developing countries (Haenlein, 2004). Pirisi et al. (2007) mentioned that in developing countries the total milk production statistics does not include unknown quantities processed directly by farmers or after collection by dairies, and sold in an organized market.

Haenlein (1993) approached the key question: “Why goat milk?” This is a critical question to be asked and answered by all who are trying to help establish a dairy goat business and industry. If goat milk superiority cannot be identified and promoted, it will be difficult justifying growth of the goat business. The same author also asked: Why buy goat milk? (Haenlein, 2004). Without reasonable evidence of added value and well being of goat milk in human nutrition, it is difficult to convince customers to buy it since it has a higher price than cow milk.

The aim of this article is to review and discuss specialty products made from goat milk around the world, with focus on goat milk quality, which leads goat producers to better life conditions and satisfaction.

2. Producing goat milk

There can be no quality goat milk specialty products if there are no healthy goats for milking, hygienic procedures, and good manufacturing practices. The health of the dairy herd should be of prime importance to any producer, especially where raw milk is used to make fresh cheeses like chevre. However, a persisting challenge for goat milk marketing and its products comes from concerns of sanitary controls and the need to install quality testing and standards. A good incentive is payment based on the quality of the product, both in nutritional composition (protein and fat) and microbiological conditions (somatic cell count and bacterial count) (Ribeiro, 2008).

Good milking practices are extremely important for udder health and production efficiency by preventing the losses in milk and money after goats develop mastitis. Good milking practices recommended include the following routines: first, milking young goats with no mastitis, then adult goats with no mastitis, followed by goats that had mastitis but are now healthy, and finally, goats in mastitis treatment (Ribeiro, 1997).

Cleaning udders before milking is obligatory, with special attention to end teats, using predipping solutions, followed by drying teats with paper towel, avoiding residues in milk. The person in charge of milking must be healthy, non-smoking, should wash his or her hands thoroughly and dress clean clothes. It’s important while milking that the first squirt of milk be recollected in a black bottom jar, observing abnormalities in milk and discarding milk with greater bacterial count, keeping milk quality higher. Performing CMT’s (California Mastitis Test) is desirable. The milking should be fast and peaceful, in order to extract all milk. After milking it is important to perform a dipping procedure, submerging the teats in a glycerinate iodine solution, and making sure that goats don’t lie down for 30–60 min. A good approach is feeding the next diet when they come back to the barn after milking (Ribeiro, 1997).

Lastly is the milk storage. When the milk first leaves the doe it is at body temperature and should, for best flavor and quality, be cooled to 4 ◦C as soon as possible. Some producers cool their milk in a cold or ice water bath, or even in a freezer. The best option is fast cooling, required for controlling lipase activity and microbiological changes in the milk tank.

The incentive criteria for quality payment of the milk can be useful in defining the selection objective in a population, region or country. However, to obtain the desired changes, it is important to establish a real incentive, i.e. a benefit above certain threshold, which is the case in the example for fat and protein content, rather than a system of allowances if the optimum level is not reached (SCC for example). Besides, it is necessary that there be technical and effective solutions for the breeders that own economically viable production systems.

Presently, the majority of goat milk in Brazil is not paid based on its chemical composition or microbiological quality; there are some cases in which a quality payment policy is applied. A good example of this is CCA Laticínios, the biggest goat milk production company in Brazil. In 2007 it collected 1,644,093 L of goat milk. This company began its activities with fluid milk in 1999 and since 2002 it practices a quality payment system. The payment is based on somatic cell count, total solid content, seasonality, and participation in a herd control program. In 2006 it began to pay a bonus for low bacterial count. Pre-requisites for raw milk purchase are acidity between 14 and 16◦D, fat above 3%, protein above 2.5%, lactose above 4%, total solids above 11%, somatic cells count below 3,000,000/mL, negative test for antibiotics and inhibitors and negative for milk from other species (Ribeiro, 2008).

3. Marketing goat milk

According to Haenlein (2004) and Park and Haenlein (2007) there are three reasons for demand of goat milk. The first one is home consumption. This demand is increasing...
because of the growing human population. The old saying, “goat are the poor man’s cow” is quite fitting. In the developing world goats can represent the difference between malnourishment and a healthy sustaining diet (Mowlem, 2005). The second aspect is the connoisseur interest in goat milk products, especially cheeses and yoghurt in many developed countries. This demand is growing because of the increasing levels of disposable incomes. The third aspect derives from a medical purpose, on the affliction of people with cow milk allergies and other gastrointestinal ailments. This demand is also growing because of a wider awareness of problems with traditional medical treatments to such afflictions, especially in developed countries.

Mowlem (2005) reinforced the importance of a health market, created by the demand for goat milk as an alternative to cow milk for people with a health problem and when goat milk is believed to be beneficial. This use of goat milk has a long history and for many years goat farmers have promoted this aspect. The same author stated that in the UK, it has been estimated that at least 5% of the population are unable to consume cow milk. Of these, it is estimated that 75% or about 2.1 million people would benefit from consuming goat milk. As more and more people with allergies and digestive problems, and the professionals taking care of them become aware of this, a large potential market is created with very little marketing effort from the producer or processor.

Goat milk and its products are now fashionable in some parts of the world, where medical needs and connoisseur interests drive these markets (Pirisi et al., 2007). Goat cheese in the United States has gained popularity among ethnic groups, gourmet and health food lovers, and goat farmers (Park, 2001).

Some market demand may not exist yet, but can be created or stimulated by innovative promotion. The first requirement would be to capitalize on identifying the uniqueness of the product. If mountain farmers are unique by only possessing goats, then their product should reflect this in name and promotion. If goat milk produces a unique cheese in quality and taste compared to that made with additional cow milk or from cow milk alone, then this would also be a promotional unique advantage. If farmers have different browse and grazing forages with their unique different tastes imparted on their goat milk, yoghurt and cheeses, then this also would be a unique promotional advantage compared to valley farmers and their dairy products.

Therefore, goats are democratic animals, used by underprivileged and privileged people. Goats are often considered by consumers as ecological animals, and their products would be more adapted to maintain human health. In industrial countries, sheep and goat cheeses are very well recognized by connoisseurs as gastronomic and festive products (Morand-Fehr et al., 2007). Nevertheless, the consumer interest in the great variety of goat milk products, especially those of “organic” origin or of traditional labels has seen considerable growth in recent years (Pandya and Ghodke, 2007).

Probably the most challenging aspect of making any business profitable is marketing the final product successfully. It can be particularly challenging for those in dairy goat production who not only have the primary job of working with their animals but then have to figure a way and find the time to sell what they have produced in order to make a profit (Hibma, 2007).

According to Loewenstein et al. (1980), flavor is the most important quality of milk in general, especially in goat milk, for its utilization in the production of consumer products. In the manufacture of some varieties of cheese a relatively strong “goat like” flavor is preferred, but for other products the absence of characterizing flavor is favorable.

An old, nevertheless fashionably present market for goat milk is the cosmetic industry. Since Cleopatra, Queen of Egypt, who bathed in goat milk, women use goat milk for beauty. This market is increasing very quickly, including handmade products such as soap and lotion.

3.1. Health market

Haenlein (2004) elucidated the nutritional and health benefits of goat milk in relation to a number of medical problems of people, where the foremost problem is food allergies with cow milk proteins. According to this revision, the prevalence of cow milk allergy varies with countries and age of people, but exact data is lacking partly because differential diagnostic methods are difficult to perform in the apparent absence of standards. There is a wide variety of genetic polymorphisms of the different caseins and whey proteins that adds to the complexity of the cow milk allergy situation, and difficulty to determine which protein is mainly responsible for an allergic reaction. According to Park (1994) β-lactoglobulin is the major whey protein of cow milk, not found in human breast milk and mostly responsible for cow milk allergy. Although some caprine milk proteins have immunological cross reactivity with cow milk proteins, infants suffering from cow milk allergy symptoms were reportedly cured by goat milk therapy.

Cow milk allergy is considered a common disease with a prevalence of 2.5% in children during the first 3 years of life, occurring in 12–30% of infants less than 3 months old, with frequency as high as 20% in some areas (Haenlein, 2004), where treatment with goat milk resolved between 30 and 40% of the problem cases.

According to Park (1994) and Jandal (1996) goat milk is prescribed by many doctors for children who are sensitive to cow milk, and is an alternative for people who are allergic to cow milk. The author found that approximately 40% of all patients who are sensitive to cow milk proteins tolerate goat milk proteins and it is very useful for people suffering from problems such as acidity, eczema, asthma, migraine, colitis, stomach ulcer, digestive disorder, liver and gallbladder diseases and stress-related symptoms such as insomnia, constipation and neurotic indigestion (Park, 1994). These patients may, in the future turn more to goat milk and its products to solve their problems. Furthermore, caproic, caprylic, capric and other medium-chain fatty acids have been used for the treatment of malabsorption syndromes, intestinal disorders, coronary diseases, premature infant nutrition, cystic fibrosis and gallstone problems because of their unique metabolic ability to provide energy.
while at the same time lowering, inhibiting and dissolving cholesterol deposits (Park, 1994; Jandal, 1996). Mowlem (2005) and Sanz-Sampelayo et al. (2007) reinforced the claim of these benefits.

According to Park (1994), Saif et al. (2004) and Park and Haenlein (2007) goat milk differs from cow or human milk in its higher digestibility, distinct alkalinity, higher buffering capacity, and therapeutic values in medicine and human nutrition. Many hospitals and medical practitioners kept a list of sources of goat milk that they could recommend to patients. The term, universal foster mother, was often used to describe the goat (Mowlem, 2005). Goat’s milk is particularly easy to digest by the young of many species apart from children. Many foals or litter of puppies has been successfully reared on goat milk.

Goat milk proteins are digested more readily and their amino acids absorbed more efficiently than amino acids of cow milk (Jenness, 1980). Some authors (Jenness, Park, Haenlein, 1980; Park, 1994; Jandal, 1996) had mentioned the higher digestibility of goat milk compared to cow milk because of its natural homogenization. The fat globules of goat milk are smaller, having a greater surface area, and lipases in the gut are supposedly able to attack the lipids faster.

The higher protein, non-protein N and phosphatase in goat milk give it greater buffering capacity compared to cow milk. Some physicochemical properties of goat milk such as smaller fat globules, higher percent of short and medium-chain fatty acids, and softer curd formation of its proteins are advantageous for higher digestibility and healthier lipid metabolism relative to cow milk (Park, 1994). Goat milk also has a greater iron bioavailability in anemic rats than cow milk.

López-Aliaga et al. (2005) listed more advantages of goat milk in their study, where supplying goat’s milk in the diet rather than cow’s milk lead to an increase in the biliary secretion of cholesterol and a decrease in plasma cholesterol concentration. The outputs of phospholipids and bile acids, and the lithogenic index remained within normal values. Moreover, consumption of this type of milk lowers plasma concentration of triglycerides and therefore has a positive effect similar to that of virgin olive oil consumed with standard diets on lipid metabolism.

Descriptions in an ancient Chinese medical text of goat milk as a tonic for the digestive system in 1578 can be supported by growth factor activity in goat milk, as revealed by Wu et al. (2006), who called goat milk a feasible nutraceutical for gastrointestinal disorders. They studied the five breeds of dairy goats, and among them the milk from Nubian goats had the highest growth factor activity, especially in late-stage lactation with concurrent pregnancy.

Many authors have called goat milk a functional food, because of its nutritional value and health maintenance properties, reduction of chronic diseases risks, and modification of physiologic functions in a positive way (Correa and Cruz, 2006). It is very important to consider goat milk a healthy, functional food. People can’t think of goat milk as just a medicine. Because of its unique differences in several important constituents and physical parameters, it is not surprising that goat milk has a higher price than cow milk (Park and Haenlein, 2007).

3.2. Effects of feeds on goat milk and products

Dietary fiber-to-concentrate ratio (F:C) can affect sensory quality of goat milk cheese. Alvarez et al. (2007) stated that the use of a diet with a high F:C ratio (65:35) compared with another diet with a low F:C affected the quality of cheese. Fat content was higher in cheese from goats fed the high F:C diet, and this fact had an important effect on the medium-chain fatty acid composition (C6–14). The chemical composition could be related to particular sensory properties such as odor and flavor descriptors. Expert judges found differences in texture, odor, flavor, and taste. The high F:C cheeses were more appreciated by the expert panel and also by a consumer test. This fact could be due to less acidity and trigeminal sensation and more solubility, taste persistence, odor and flavour intensity as well as the presence of vegetable, fruity, and dried fruit descriptors. This is important especially when milk is transformed into Protected Designation of Origin (PDO) cheeses. Pasteur based farming systems result in milk performance characterized by high fat content due to diets rich in fiber. Such milks are rich in micro-components (fatty acids, vitamins) and in volatile compounds (flavors, terpenes) favorable to human nutrition and health (Morand-Fehr et al., 2007).

3.3. Sensory characteristics and gourmet market

The flavor profile of a cheese is dependent on the variety and type. Organic acids are important compounds affecting flavors of most aged cheeses. They are formed as a result of hydrolysis of milk fat during lipolysis, bacterial growth, normal ruminant metabolic processes, or addition of acidulants during cheese making (Park and Drake, 2005).

In a survey about consumer perceptions and vendor practices in cheese quality, Teng et al. (2004) found good safety practices through pre-packaging of product and clean premises. About 47% vendors had problems with refrigeration, while the majority of vendors did not wash their hands. Approximately one-half of the consumers surveyed did not purchase farmers market cheese, and identified distance from home as the main reason.

Sensory properties of goat cheeses are an important factor for consumer acceptability and marketability of the products. Most sensory and textural attributes of cheeses increase during ripening (Park and Drake, 2005). Selection, freshness and flavor were listed as the primary reasons for purchasing farmers market cheese (Teng et al., 2004).

France has developed a specific and organized dairy goat sector since the early 1950s with the creation of goat milk cooperatives and dairies in the central western region (Dubief, 2005). They have developed quality control of milk, milk collection and other professional services and organization. A large range of lactic cheeses have been developed considering consumer tastes. According to Pirisi et al. (2007), in Europe, over recent years the tendency has been a slight reduction in the number of animals bred, while at the same time there has been a general increase in the volume of milk produced. The price of goat milk is generally higher than that of cow milk, even though in certain areas of production it is not specifically exploited, being blended with cow milk for the production of mixed cheeses.
The two markets, health and specialty foods, do not seem to be price sensitive. People buying goat products for health reasons are unlikely to worry too much about the cost, particularly if they can see some benefit from the consumption of these products (Mowlem, 2005).

3.4. Beauty market

Since the beginning of the last century, the importance of cosmetic science has become an undeniable fact, working not just in body beauty, but improving personal appearance, contributing to skin aging prevention and against other factors which can cause damage to health (Schueller and Romanowski, 2001). In 1400 B.C., Egyptians used the first cosmetics, such as eye pigments, rouge, henna, goat milk, olive oil and simple creams (Silva, 2005). Cleopatra is the most important marketing woman of goat milk in history! Presently there are many skin and hair treatments using goat milk in natura or cosmetics which have goat milk as the base ingredient.

According to Barata (2002), the main functions of cosmetics are cleaning, correction and protection. Silva (2005) added a fourth function, decorative. These functions are further depicted as follows:

• Cleaning: Elimination of impurities from external origin and degradation products, respecting physiologic equilibrium of tissues. Soaps, detergents, creams and lotions are in this category. Goat milk is a good choice, because it has a pH similar to human skin, cleaning without aggressive or allergenic side effects.

• Correction: To reestablish the altered equilibrium, returning natural beauty. Creams and gels are in this category. Goat milk is a good moisture agent in this case.

• Protection: avoiding irrational cleaning or impeding atmospheric agents alter the skin properties. Sun blocks and creams are in this category. Goat milk has capric and caprylic acids which will help in this case.

• Decorative: Embellish skin and annexes. Creams, foundations, lipstick and eye pigments are in this category. Goat milk is a good moisture agent, especially for lips.

There are few literature sources about goat milk value in cosmetic formulation. Testing nine formulations searching for a good permeation enhancer in human skin, Wongpayapkul et al. (2006) found that there was a trend which indicated that the formulation containing oleic acid or caprylic acid showed a higher flux than the other formulations.

Among different options for treatment of burned patients, Ferreira et al. (2003) mentioned the utilization of enzymatic balm and essential fatty acids (EFA), compounding of linoleic and caprylic acids, vitamin A, E and soy lecithin. The EFA are precursors of pharmacologically activates substances, involved in cell division and epidermis differentiation. They have the capacity of modifying inflammatory and immunologic reactions, altering leukocyte functions and accelerating tissue granulation process. Goat milk as a good skin regenerator, caprylic acid is the main active compound. Besides, the small size of fat globules allows their penetration in the middle skin stratum (dermis), moisturizing and making it turgid and "younger".

4. Products from goat milk

Loewenstein et al. (1980) asked an important question: “Why is a greater amount of goat milk not used when there is such a shortage of high quality protein?”. The answer was that there is a lack of knowledge and inability to utilize milk in forms conducive to human consumption in a wide variety of circumstances.

Jandal (1996) and Haenlein (2004) noted that there is few data available on products such as butter, frozen yogurt, and the manufacture of fluid goat milk products such as low fat, fortified or flavored milks, cultured products such as buttermilk or yogurt, frozen products such as ice cream, condensed milk and dried milk products. There is a lack in goat milk research and this needs more attention. However, some research on dairy goat products has been reported recently (Park, 2005; Park and Guo, 2006a,b).

Pandya and Ghodke (2007) also reiterated that there is a scarcity of publications on the manufacture of different products from goat milk, probably because of the much greater volume of cow milk, making them more suitable for efficient commercial interest compared to goat milk. However, Park and Guo (2006a,b) and Pandya and Ghodke (2007) described various goat milk products, including dry whole milk, dried granulated milk, maize meal with goat milk, condensed goat milk, fruit yogurt, tvorog (full cream, strawberry, garlic and “French-style”) soft cheese, blue cheese and hard cheese besides cream, butter and butter oil, cultured goat cream butter, ice cream, whey protein concentrate and evaporated milk, Indian traditional products like Chhana, Paneer and Ghee, and Turkish butter from goat milk like Yayık.

Jandal (1996) reminds us of some aspects that differ from goat, sheep and cow milk: goat and sheep milk is white compared to cow milk, which is yellowish because of the presence of carotene. Goat milk may have a stronger flavor than sheep and cow milk, due to short-chain fatty acids as a result of improper handling. Goat milk is slightly alkaline in nature while cow milk is slightly acid. Besides, goat milk has higher proportions of short-chain fatty acids such as caproic, caprylic and capric acids than sheep milk. Loewenstein et al. (1980) found that the sensory evaluation of a slightly salty flavor of goat milk is due to slightly lower lactose and greater chloride contents of goat milk as compared to cow milk. This is not a problem for regular consumers.

According to Mowlem (2005), in the UK, from 15 to 20 million L of goat milk are processed for consumption each year, of which 60% are for cheese, 20% for fluid milk, 10% for yogurt, and the rest for butter, cream and ice cream. One of these products is a range of cartoned milk for drinking that includes whole, skimmed, semi-skimmed and UHT milk.
4.1. For human consumption

4.1.1. Fluid milk

Goat milk may be fortified with minerals, vitamins, and others additives and may be reduced or reduced in fat. The process and packaging can vary a lot. There are various types of fluid goat milk around the world. Some countries have more whole milk commercialization while others prefer skim milk. Some countries have a legislation for vitamin inclusion. Another variation can be seen in the size of the packaging, from 454 g to 3.6 L for home consumption. Packaging comes in different materials: plastic, paper carton or glass. Shelf life varies, depending on processing, type of package and specific legislation. Loewenstein et al. (1980) mentioned the increasing consumer appeal for low fat, protein fortified milk in the United States some years ago. They projected that processing this product would allow accumulation of fat for ice cream or other high fat products.

4.1.2. Evaporated and dried milk

Evaporation is usually done under reduced pressure, primarily to allow boiling at a lower temperature to prevent heat damage. Powdered products include powdered whole milk, skim milk, whey and infant foods (Park, 2005) and evaporated, condensed goat milk (sweetened) or unsweetened. According to Pandya and Ghodke (2007), literature on the manufacture of powdered goat milk is limited, possibly because of the unavailability of large quantities of goat milk from the small production farms. But a reason of unavailability is an industrial secret since big enterprises do not want to have their procedures known.

There are basically three forms to manufacture dried milk powder from goat milk (Pandya and Ghodke, 2007): freeze drying, roller drying, and spray drying. In Brazil the technique utilized is spray drying and pulverization. The processes of spray drying and pulverization utilize the preconcentrate product for pulverization in the dryer camera, with dry matter around 46–48%, obtained by evaporation under vacuum at low temperature (∼65 °C). This is used in order to help and optimize the procedure.

4.1.3. Cheeses

Cheese may have been one of the first manufactured foods consumed by humans. History records its usage more than 4000 years ago, but no one really knows when the first goat milk was made into cheese (Loewenstein et al., 1980).

Goat cheese was originated in Mesopotamia. The milk was probably made into soft cheese, and then hard, ripened goat cheeses were later developed in the Mediterranean basin countries (Park, 2001). There are goat cheeses made from raw and pasteurized milk. In many countries the manufacture of goat cheese from raw milk is prohibited due to food safety issues (e.g. brucellosis). The type of milk used significantly influences the finished cheese (Loewenstein et al., 1980).

Numerous varieties of goat cheeses are produced worldwide. Maturation or ripening of cheeses from goat milk and milk from other species is governed by many different factors (Park, 1990). Besides, manufacturing techniques include wide variations in amount and species of organism used in culturing, incubation procedures, and forming or pressing techniques. Variations in aging time and conditions play the most important part in determining the flavor, body, and texture of cheese. Most goat cheeses are made by procedures involving slow coagulation, curd remaining with whey until dipped into molds, and drying of the cheeses before ripening.

Proteolysis and lipolysis are two major biochemical processes in the multifaceted phenomenon of cheese aging, which involve a variety of chemical, physical, and microbiological changes under controlled environmental conditions. Proteolysis of cheeses in general is influenced by several factors including plasmin, chymosin, protease from starter and nonstarter bacteria, pH and moisture levels of the curds, storage temperature and time, salt content, salt-to-moisture ratio, and humidity. Primary factors affecting lipolysis in cheeses are fatty acid composition, lipolytic enzymes, lipolytic microorganisms, moisture, temperature, storage time, oxygen, and surface area, among others (Park, 2001).

The large number of varieties of cheese made from goat milk has resulted in a great diversity in the nature of the products. Paneer is an important indigenous Indian dairy product and is traditionally a variety of pressed Channa (Pandya and Ghodke, 2007). Actually it represents a soft variety of uncured cheese, which is similar to Cottage, Queso Blanco, Quark, etc., manufactured using heat and direct acid coagulation in many other countries.

Loewenstein et al. (1980) and Park and Guo (2006a,b) described goat milk whey cheese, which is especially popular in Norway, the process where caramelized lactose in concentrated whey is combined with fat and whey proteins to make Gjetost cheese. Ricotta is a kind of cheese which may be made from goat cheese whey; cheeses of a similar nature have other names when made in other countries. Broccio is a whey cheese made by combining goat milk with the whey from goat cheese. Many traditional goat cheeses are made in developing countries.

4.1.4. Fermented milk

The proportion of goat and sheep milk processed into cheeses and yoghurts is higher in comparison to cow milk (Morand-Fehr et al., 2007). Since 5000 B.C. the nutritional and health values of fermented milk and beverages were described (Prajapati and Nair, 2003). As a process, fermentation consists of transformation of simple raw materials into a range of value-added products by utilizing the phenomenon of growth of microorganisms and/or their activities on milk.

Kefir is a viscous, refreshing drink, with high acidity and varying amounts of alcohol and carbon dioxide. Commercial production of Kefir occurs in many countries, particularly in Eastern Europe (Prajapati and Nair, 2003). It is also manufactured under a variety of names including kephir, kiaphur, kefer, knapon, kepi and kippi, with homemade production occurring in countries as widespread as Argentina, Taiwan, Portugal, Turkey and France (Farnworth, 2005). Kefir is still most familiar to consumers in Eastern Europe, although commercial production now occurs in North America. Kefir has had a long history of health benefits in Eastern European countries, where it is associated with general wellbeing and often the
first weaning food received by babies. Health benefits of kefir were stated by Farnworth (2005), including stimulation of the immune system, inhibition of tumor growth, antimicrobial properties, gastrointestinal tract benefits and positive effects on cholesterol metabolism.

Prajapati and Nair (2003) and Park and Guo (2006a,b) also mentioned Dahi, an Indian fermented milk product, popularly known as a good food, because of its nutritional and therapeutic value. Many traditional fermented goat milks are made in developing countries.

4.1.5. Desserts

Ice cream made from goat milk is an attractive alternative for children and other consumers, due to its nutritional and antiallergenic properties and creamy organoleptic properties. Ice cream and frozen yogurt manufactured from goat milk are usually flavored. Vanilla, chocolate, and premium white chocolate mix are the most commonly used flavors (Park, 2005).

Konar and Akin (1997) and Pandya and Ghodke (2007) compared the chemical, physical and organoleptic qualities of ice cream made from cow, goat and sheep milk for their suitability for ice cream production. Goat milk produced the most acceptable ice cream followed by cow milk. Correia et al. (2008) agreed, concluding that goat milk ice cream has a softer texture and specific melting characteristics.

Chakka is a concentrated product obtained after draining the whey from Dahi (fermented milk product). Mixing Chakka with sugar and other condiments results in Shrikhand, a very popular and traditional dessert in Western India (Prajapati and Nair, 2003). Chhana is a heat and acid coagulated traditional Indian milk product (Park and Guo, 2006a,b; Pandya and Ghodke, 2007). It is used as a base material for the manufacture of sweets, particularly in the eastern part of India. Goat milk Chhana is slightly acidic.

4.1.6. Sweets

Cajeta is a Mexican goat milk candy. It is a rich caramel sauce made from goat milk. It can be found in several flavors (primarily caramel or quemada (plain), vanilla and liquor flavor) (Park and Guo, 2006a,b). It is used in Mexico and in some South American countries primarily as a dessert by itself or as a topping for ice cream or fruit. In Argentina, Chile, Uruguay and Peru it is used to prepare Alfajores (Caramel Sandwich Cookies). In Mexico they are called Obleas. Other Mexican traditional candies using goat milk are Glorias (with nuts), Queso de nuez (also with nuts), and Chongos Zamoranos (cinnamon flavored). A famous American goat milk candy is fudge, which can have chocolate added to it.

There is a Brazilian traditional candy in the state of Minas Gerais called Doce de leite, manufactured mainly with cow milk. However there is also the same kind of candy made from goat milk. It is pasty and sweet, plain or with coconut, and includes Brazilian nuts or dehydrated fruits. There is also a Brazilian traditional candy made from sugarcane called Rapadura. Some Brazilian producers are making goat milk Rapadura (Rapadura de leite de cabra), mixing goat milk and sugarcane. It can include peanuts, coconut or chocolate.

Chocolate goat milk can be produced, including organic chocolate goat milk in some countries. Cookies can also be made from goat milk. Each region has some typical cookies made from cow milk adapted to use goat milk. In Brazil we can find Beliscão and Sequilhos.

4.1.7. Butter-like products

Cream is produced by mechanical agitation of the whole milk to separate the fat globules. The fat globules are aggregated to form a semi-solid mass with 80–85% fat, transforming into butter. Cream and butter are manufactured from goat milk, but are almost entirely consumed by those seeking to avoid cow dairy products for health reasons (Mowlem, 2005). Butter milk is usually made from skim goat milk (less than 0.5% fat) using a by-product from butter processing, according to Park (2005) and Park and Guo (2006a,b).

Physiochemical, microbiological and organoleptic characteristics and fatty acid profiles of traditional Turkish “yayik” butter from goat, sheep or cow milk were compared by Sagdc et al. (2004). The yayik butter made from goat milk had the most acceptable organoleptic characteristics.

Ghee (or heat clarified butter fat) is a fat rich product, mostly used as a cooking medium in India and other tropical countries. It is manufactured by fermenting whole milk into curd and churning out butter, followed by heat clarification at 105–145 °C (Park and Guo, 2006a,b). Goat milk is not considered suitable for the manufacture of Ghee for some authors, because of the relatively small fat globules, which may present problems during cream separation (Pandya and Ghodke, 2007). Ghee is called butter oil in some countries (O’Mahony and Peters, 1987).

Rodriguez et al. (2003) studied the development and optimization of cultured goat cream butter, made with goat milk cream inoculated with freeze-dried mesophilic aromatic lactic cultures in Chile. It showed an increase in acidity and a decrease in lactose content when the concentration of lactic cultures was increased. The lactic culture concentration significantly affected flavor, sensory texture, and overall quality, but the fermentation time did not produce significant changes in sensory texture and overall quality. This cultured formulation achieved optimal sensory quality in appearance, flavor, texture, and overall quality.

4.1.8. Whey products

Goat milk whey has higher levels of alpha lactalbumin (Pandya and Ghodke, 2007), but is often discarded, or given to animals as nutritional supplement, and little information on it is available. However, presently there are many products made from whey goat milk, among them are whey goat milk flavored beverage, tablets (chewable), whey protein concentrate, and athletic supplements.

4.1.9. Cosmetics

Recently a high volume of cosmetic products are produced from goat milk, including soaps, creams, body lotions, shampoos, hair conditioners, after shave lotions, which are marketed in many countries such as US and Switzerland. However, sometimes there is no goat milk in these; even though it says so on the product. It is very
important to be careful choosing a real goat milk product. In Latin American countries such as Brazil, Guatemala and Mexico (Ribeiro et al., 2007) some goat producers are making goat milk cosmetics.

Shampooing is the most common form of cosmetic hair treatment. The diversity of qualities expected from a shampoo by today’s consumer surpasses the primary function of cleansing. Current shampoo formulations are adapted to the variations associated with hair quality, hair care habit and specific problems related to the superficial condition of the scalp (Trueb, 2001). Goat milk is likely to enhance hair care and avoid damaging hair in the process.

Goat milk fat contains capric and caprylic acids which enhance permeability in skin, qualifying to be used as a carrier of other chemical compounds in lotions and creams (Mahjour et al., 1993; Wongpayakul et al., 2006).

4.1.10. Other food usages

In some countries, customers can find breakfast cereals with goat milk, and baby food and sweet and salty pies made from goat milk and cheese. These products are increasing in variety and quantity. Industrialized whole goat milk is also used for pet consumption. This includes pet care products (cosmetics) produced in some regions (Ribeiro, 2008).

5. Conclusions

Although goats have been the most defamed domesticated animal in many countries, it has played an important role in human nutrition, wellbeing and survival around the world. Goat milk and its products can provide producers with a good farm revenue and economic viability. Goat milk can be manufactured for specialty products in the farm and commercial processing plants, depending on facilities and marketing organization in different regions. Goat milk and its processed products are greatly useful as functional foods, maintaining nourishment and health for young and elderly, especially those who have cow milk allergy. Connoisseurs and gastronomy chefs look for goat milk products, because of their flavor, texture and diversity. The processed goat milk specialty products are expected to have a good market prospect. Goat milk also has a great potential in expanding its horizon into beauty, skin care and cosmetic markets. Worldwide demand for goat milk products has been increasing, and future demand for caprine cheeses, is specially promising. The success of the goat milk industry will be virtually dependant on the establishment of high-producing dairy goat herds, production of high quality milk, improved and carefully controlled product manufacturing, packaging, storage and distribution techniques. The production of quality goat milk through professional breeding programs can be rewarding, profitable, pleasant and successful.

References


