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Composition, Attributes and Benefits of Goat Milk: Literature Review

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ABSTRACT

Goat´smilk and cow´s milk have similar compositions. The former ishealthy and nutritious, and it is a validalternative to human´s milk becausetheir nutritional values are also very similar. Manypeoplewho are allergic to cow´s milk can drinkgoat´smilksafely, as itcontains a different protein. Goat'smilkis graduallybecoming more popular in worldmarkets, beyondthecountrieswhereitisalreadyone of themajorcomponents in thediet of millions of people today. To produce goodqualitymilk somebasicefficiency principles of livestock farming must be taken into consideration, likegoodquality animals, selection ofdairygenotypes, adequatefood supply, goodmanagement and health. Thefirsttwohave direct effects on thethenutritionalqualityorcomposition of milk; theothertwo have to do withhygiene. This paper reviews themainaspectsthatinfluencegoat´s milk composition, biologicalvalue as substituteforhuman´smilk, maincomponents, and qualities and benefitsto human health.

Keywords:*goat´smilk, milkcomposition, quality of milk*

INTRODUCTION

Goat was the first animal domesticated by man that could produce food for humans, about 10 000 years ago. Since then, goats were present along history, according to several historical, mythological and Biblical accounts that mention the caprines. However, few times had they been recognized (Doria, 1997, Bidot and Muñoz, 2016).

Goat milk has been used for human nutrition since ancient times. Very old records in the Bible or Egyptian murals referred to the consumption of goat´s milk. Its history is linked to the history of man, who has always used the goats´, meat, fur, leather, manure and labor. These products are important indicators of the species´ capacity to adapt to multiple climates and systems (Cofré, 2001).

Most part of the caprine population, approximately 444 000 000 (95%), lives in developing countries, and they are used as dual-purpose (meat-milk) animals. However, the industrial countries only have 5% of goats (30 000 000), especially for milk production (27% of total world milk production) (FAO, 1982).

According to FAO (1987), goats are one of the few species that can survive and even produce food in adverse conditions, with harsh climates and scarce natural resources.

The goat´s milk demand estimated by FAO by 2000 was 177.6 million tons, mostly from developing tropical countries (Knights and García, 1997). By 2010, FAO recorded 909 million of heads, whereas the countries with the largests numbers were India (154 million), China (150 million), Pakistan (59 million), and Sudan (43 million).

In the MERCOSUR countries, the caprine production combined accounts for 1.8% of the world´s total: Argentina (4.2 million), Brazil (9.3 million), Paraguay (135 thousand), Chile (750 thousand), and Uruguay (16.7 thoussand) (Bedotti, 2008; FAO, 2010.

Despite its important contribution to human nutritional support and other areas (clothing, labor, fertilization), goats have been reviled as an enemy of ecosystems and large contributors to the loss of cropland. Hence, they have been isolated to desserted and irregular places. Goats are also considered responsible for transimitting diseases to humans (brusselosis, Malta fever), and for spreading them worldwide through the large commercial and agricultural routes. Based on such pejorative considerations and other causes (geographic, social, economic, situational) caprine raising has undergone unequal evolution in different parts of the world (Vacas, 2003).

López*et al.*(2011) noted that the marginality of farm productions, especially caprines, is characterized by the absence of practices that provided added value to productions. The family rationale to increase income is to have large numbers of animals, instead of managing less and get higher productivity from them. Either will require proper technology according to the ecological and socioeconomic circumstances, as well as the markets to sell.

Goat milk has been a key component in the Mediterranean diet originally, particularly for-

making cheese, as noted by the literature classics Caton, Virgilio, Columela, Plinius, and Atheneus. They not only showed how to make cheese, but also the kinds available ("oxigala", "moretum"), or even some recipes, like pie ("sabilium"), made of cheese, honey, flour and eggs, powdered with poppy seeds and baked in the oven (Otogalli and Testolin, 1991; Capdevila and Martí-Henneber, 1996). In ancient times, fermented milk was mentioned in the Bible´s Deuteronomy, as "one of the foods given by the Lord to His people". Since then, goats have played a key role in quality foods for humans, especially in poverty-stricken areas of the world, where these foods continue to be the main source of proteins for the people (Bidot, 2006b). A tenth of all the milk consumed in the world is produced by goats; for some countries, it is the only source of milk (Arbiza, 1987).

Goat´s milk demand has increased, mainly due to demographic boom, and the particular interest in goat´s milk by-products in developed countries (yogurt, and cheese), because they can be consumed by groups of people who are lactose intolerant. Goat milk composition is associated to certan nutritional benefits to children, and the development of functional foods and by-products with particular sensorial features required by consumers. This food and its derivatives are another choice to invigorate regional economies (Arbiza, 1996; Haenlein, 2004; Vega and León *et al*., 2010).

DEVELOPMENT

Composition of goat milk (Table 1)

From a technological perspective, milk composition determines its nutritional quality, properties and value as raw material to make foods. Goat´s milk has the highest nutritional and therapeutical values, only second to human´s milk, with a high nutritional quality and agreeable taste. The therapeutical properties of goat´s milk were acknowledged since the beginning of civilization, proving its power against gastrointestinal ailments (Flores Cordova *et al*., 2009).

Milk is the white-beige, fluid product secreted by the female´s udder, with a particular odor and taste. It is rich in nutrients and easily contaminated if not properly collected. In general terms, goat milk is matt-white and slightly viscous, and its composition and physico-chemical features are very sensitive. Some of the factors that contribute to these variations are, the breed, nutrition, season, environmental conditions, area, lactation conditions and udder health (Chilliard *et al*., 2003; Park, 2007a; Park *et al*., 2007).

The goat´s milk is whitier than the cow´s milk because it has no carotene that provide a yellow tone. Carotens are red, orange or yellow non-saturated hydrocarbons found in tomatoes, carrots, egg yols, and other plants. In animals, it is transformed in vitamin A. Goat´s milk has a strong odor caused by the absorbtion of aromatic compounds during husbandry (usually inadequate substances), with the presence of males in the milking areas, poor housing hygiene, delayed skimming and after-milk cooling. The said odor and taste can be removed by vaccuum deodorization, which is very simple (Borras, 1968). Cow´s milk is slightly acidic, whereas goat milk is almost alkaline (pH 6.7), due to higher protein contents and different phophate combinations (Saini and Gili, 1991), so people with digestive problems are encouraged to consume this kind of milk (Jandall, 1996). Goat´s milk is a balanced combination of proteins, fats, carbohydrates, salts and other components. Milk composition determines its nutritional quality and its value as raw material to manufacture foods for humans. Its qualitative composition is stable, but it varies concerning the animal breed, the lactation time, number of deliveries, season, and local climate. Other authors describe milk as a white and opaque liquid with a complex composition, slightly sweet and an almost neutral pH. It is a suspension of protein elements within serum made by lactose and mineral salts, mainly (Alais, 1988; Ortega *et al*., 2011).

According to Vargas *et al*. (2007), milk is a white, opaque liquid, twice as dense as water, slightly sweet and with little odor. It is a very complex chemical and physical system, and it can be considered an emulsion of fatty matter in an aqueous solution that contains various dilluted or colloidal elements.

According to the definition of milk, adopted by the I International Conference for Food Fraud Repression, in Geneva, 1908, it is "the product...colostrum..." It basically coincides with the definition established in the Spanish Nutritional Code (Real Decree 2484/1967, Spetember 21), Chapter V, which noted that milk is the whole product without alterations or forgery, without colostrum from regular, clean, complete, and unin-

terrupted milking of healthy well-fed mammal females." (Vargas *et al*., 2007).

A WHO report, Series of Technical Reports No. 124, Geneva, 76, 5, 1957, established that milk and dairy products which are produced without proper hygienic conditions may be the cause of diseases in the humans that consume it. Therefore, milk hygiene comprises dairy animal hygiene, application of adequate hygienic methods for production, handling and manufaturing of milk and dairy products, pasteurization, or other forms of heat treatments to destroy pathogenic germs, and the protectection of the productagainst further contamination. The Comittee resolved that its attention had to be focused on hygienic issues related to cow´s milk (including buffalos), then goat´s milk. Additionally, issues related to dairy productcs, like butter, cheese and ice cream would be considered by another Comittee of Experts, called upon by WHO and FAO (Meneses, 2007).

Today, milk is gathering greater importance, especially in terms of protein percents. Milk rich in total solids can produce higher yields in dairies. The caprine dairy industry must have information on the milk collected and sent by suppliers over a year, and measure the physical and chemical parameters useful to accept or refuse the main product and pay the manufactures (Cruz *et al*., 2012).

The composition of milk is 77-80% water, and 20-23% total solids. They are usually composed of 3-3.5% fat, 3-3.5% protein, and 4-6% of carbohydrates, like lactose and minerals (calcium) (Salvador *et al*., 2006).

Nutritional facts of goat´s milk (Pérez, 2001). In 100 grams of goat´s milk there are,

Calories: 70 kilocalories

Carbon hydrates: 4.5 g

Proteins: 3.3 g

Fats: 4 g

Cholesterol: 11.0 mg

Glycemic index: 24

Vitamins: A, D and C; lower in vitamins B1, B2, B3, B5 and B12.

Minerals: calcium, phosphorous, potassium, magnessium, iron, zinc,selenium, manganese and copper.

Other authors compare cow´s and human´s milk to goat´s, though there may be differences in terms of breeds and nutrition.

The goat´s milk protein often has a range of essential and total aminoacids of 0.46, and of esentials against nonessentials, of 0.87 (Singh and Singh, 1985). The size of casein mycells is lower in goat´s milk (50 nm), compared to cow´s milk (57 nm) Alais, 1988). The caseins in goat milk have larger glycine contents and less arginineand sulphur aminoacids, especially methionine (Capra, 2004).

The mineral contents of goat´s milk is greater than human´s milk. Goat´s milk contains about 134 mg of Ca and 121 mg of P, per 100 of milk. It can even have up to 13% more calcium than bovine´s milk, but it is not as good a source of iron, cobalt and magnesium. Table 4 shows the values reported for the amounts of minerals found in goat´s and cow´s milk (Park, 2006).

In short, milk must be of good quality for consumption as milk, or as by-products, which means that besides having high nutrient contents,it must have special features that guarantee fresh, nutritional and healthy products on the market(Rodríguez and Valencia, 2006).

Properties

Goat´s milk is close to perfection, with an amazing struture, very similar to human´s milk. The differences in many cases mean a broad number of nutritional advantages for goat milk over many of the traditional sources (Chacón, 2005).

Goat´s milk is a valid alternative to human´s milk, as their nutritional values are largely similar. The taste of goat´s milk has little differences compared to that of cows´; they have similar levels of iron, protein, fat, and vitamins C and D.It also has higher contents of potassium, manganese, phosphorous, and vitamins A and B. Doctors and dieticians prescribe this substance as an alternative to bovine milk to people with milk allergies and lactose intolerance. It is also helpful to the elders with intestinal disorders. The international medical corporation certified that goat´s milk can revert allergies in children in 50-80% of the cases. Also important is that children who suffer such disorders account for 7% of the world population (Fuenmayor, 2012).

Goat´s milk compares to human milk in that it is healthy and nutritious. Many people who suffer from cow´s milk allergies may drink goat milk instead, because it contains a different kind of protein (Sánchez, 2011; Bidot *et al*., 2014).

The protein profile of goat´s milk is closer to that of humans, as caprine lactoglobulin is more

easily digested than cow´s. Approximately 40% of patients sensitive to the proteins of cow´s milk can tolerate goat´s milk proteins, because lactoalbumin is immunospecific for the two species (Chacón, 2005).

Fat accounts for 3-6% of milk. The quality of caprine milk fat is an important factor, since it defines the capacity of milk for processing. It plays a key role in nutritional and sensorial qualities of by-products (Chávez *et al*., 2007).

As in other ruminant species, goat´s milk fat may be affected by different factors, like breed, individual features, state of lactation, handling, climate, and feed composition. The lipid component is the most important in terms of costs, nutrition, and physical and sensorial features of the product. Within lipids, tryglycerides represent about 98%, but goat´s milk also has some simple lipids, like diacylglycerol and cholesterol esters, as well as phopholipids and liposoluble compounds, like cholesterol and esterols (Park, 2007b).

Richardson(2004) said that the fat of goat´s milk is a concentrated source of energy; one unit of it is 2.5-fold more energetic than common carbohydrates. Triglycerides represent almost 95% of total lipids, whereas phospholipids are about 30-40 mg/ ml, and cholesterol is 10 mg/100 ml.

The fat composition of goat´s milk is the main factor responsible for high cholesterol, because it prevents absorption of excess saturated fats in the organism. Hence, LDL cholesterol and triglycerides are reduced, whereas HDL increases (CAPRAISHISPANA, 2011).

Additionally, goat´s milk is characterized by small fat globules (2 µm in goat vs 3-5 µm in cows), which is associated to better digestibility (Alais, 1988; University of Maryland, 1992).

The contents of essential and long chain fatty acids make goat´s milk a healthy food for the heart (Capra, 2004). It is also important in the diet of children with atypical forms of eczemas attributed to human´s milk with an abnormal profile of fatty acids, especially,linoleic acid (Haenlein, 2002).

Benefits of goat´s milk

Many authors have described the benefits of consuming it (Bello, 1995 a and b; Arbiza, 1996; Haenlein, 2004; Candotti, 2007; Sánchez, 2011). A tenth of the milk consumed in the world comes from goats, and for some countries, it is the only source of milk (Arbiza, 1987).

The effects of cow´s milk allergens on one-year-old children are 3-8% (Maree, 1978; Grezesiak, 1989). The same allergy is observed in 2.5 - 5% of the total world population, with children as the most vulnerable group (Capra, 2004).

In general terms, goat´s milk is estimated to supply all the protein an 8 year old child needs, and 6% of proteins needed at 14. In addition to it, each liter of the milk contains 35 g of protein, 54% of the 65g/day required by lactating or pregnant women (Capra, 2004; Candotti, 2007).

Milk is one of the most comprehensive food for humans due to its component traits; proteins contain large amounts of essential aminoacids for nutrition (Paz *et al*., 2007). Being one of the most complex foods to humans, most countries regard milk production and supply a national priority, and enforce protectionist legislation in this sector (Aréchiga *et al*., 2008).

Goat´s milk demand has increased mainly due to demographic increase and the particular interest in goat´s milk by-products in developed countries (yogurt and cheese), because they can be consumed by groups of people who are bovine lactose intolerant. Goat´s milk composition is associated to certan nutritional benefits to children, and the development of functional foods and by-products with particular sensorial features required by consumers. This food and its derivatives are anoher choice to invigorate regional economies (Arbiza, 1996; Haenlein, 2004; Vega and León *et al*., 2010).

The quality of foods for human consumption largely depends on its potential contribution, both to consumer´s sustenance and consumer´s health improvement (Es, 1991). As a result, a number of functional foods, nutraceutics, pharmafoods, modified foods, or substances regarded as nutrients, which can also bring health have been introduced in the market. Also included are designed foods, made to serve a particular purpose or satisfy specific needs of come population groups (Pszczola, 1993; Bello, 1995 a and b), with the common goal of bringing benefits to health. The nutritional composition of goat milk is quite different from other animal-originated foods (Tables 2 and 3), and it is characterized by some nutraceutical traits that make it beneficial to humans. In that sense, it is important to improve the nutri-

tional composition of milk, and sell products with added value. For instance, the nutritional composition of goat milk may be affected by several factors in the diet, including the amount of fiber and the relation between forage and concentrated feeds, which cause major changes, particularly in milk fat (Bedoya *et al*., 2011; Bidot and Bidot, 2006a).

Goat´s milk is a much healthier alternative if consumed whole and from an organic source. The Physiology Department of Granada University has reported that goat´s milk has more beneficial properties to humans than cow´s milk. The paper was published in the journal Andalucía Investiga, and it adds that goat´s milk helps prevent ferropenic anemia (lack of iron) and bone demineralization (osteomalacia). Estimates say that 2% of the milk consumed in the world is produced by goats. Probiotics and other products made from milk are, by far, better than their analogues from cow milk (Solís and Castro, 2007); Flores Córdova *et al*., 2009).

Beyond the its economic possibilities and use to meet the daily nutritional demands, goat´s milk has qualities that make it suitable for children, adults, and lactating mothers (nutraceutical and antiallergic properties). Poorly fed children have seen the benefits of goat´s milk as an improved susbtitute for cow´s milk (Bostaurus) (Gilbere and Hom, 2002; Capra 2004). However, pediatricians do not recommend it as a complete substitute for human´s milk in lactating children under one, due to its high contents of proteins and minerals and low contents of carbohydrates, folic acid and vitamins C, D, E, B6 and B12 (Darnton *et al*., 1987).

In short, goat´s milk is helpful to people with digestive issues (gastric ulcers, gastritis, liver disorders, and intolerance to cow´s milk lactose. Regarding allergies, especially those caused by certain bovine dairy proteins, goat´s milk has these features,

Similar amounts of sugar and olisaccharide fractions to human´s milk;

A different protein that prevents allergic reactions for consuming cow´s milk;

Goat´s milk lactose is lower than cow´s and human´s milk (13% and 41%, respectively). Very low lactose levels make it antiallergic;

Globules or fat drops are smaller and more easily degraded by digestive juices, making it more digestible;

It is more easily tolerated by babies, provided that the mother is unable to breastfeed;

Easier digestion, especially suitable for patients recovering from gastric ailments, ulcers and collitis, thanks to high buffer properties (neutralizes acidity);

The faty acids contained in goat´s milk have the unique capacity to limit cholesterol deposition in body tissues. Cholesterol is lower;

Compared to cow´s milk, it has the same amount of proteins, fat, iron, and vitamins C and D. Goat´s milk is more abundant in vitamins A and B, and it has lower lactose contents;

It protects against osteoporosis;

It protects against ferropenic anemia.

CONCLUSIONS

Due to its traits, biological value as substitute of human´s milk, main components and qualitites, and the benefits for human health, goat´s milk is recommended for children that cannot tolerate other types of milk when they have allergies to particular bovine dairy proteins, as well as for some people with digestive problems, like ulcers, gastritis, liver disorders, cachexia,or are unable to tolerate cow´s milk.

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Table 1. Composition of goat´s milk

Composition of goat milk (%)	
Total solids	11.70-15.21
Protein (Nx6,38)	2.90-4.60
Fat	3.00-6.63
Lactose	3.80-5.12
Ashes	0.69-0.89
pH	6.41-6.70

Source: Boza *et al.*, 1992, cited by Cruz *et al.*, 2012

Table 2. Comparison of milk composition in different species (%)

Component	Goat	Sheep	Cow	Woman
Water (%)	86.20	80.90	87.50	88.35
Fat (%)	3.80	7.62	3.67	3.67-4.70
Nonfatty solids (%)	8.68	10.33	9.02	8.90
Lactose (%)	4.08	3.7	4.78	6.92
Protein (%)	2.90	6.21	3.23	1.10
Casein (%)	2.47	5.16	2.63	0.40
Serum proteins (%)	0.43	0.81	0.60	0.70
Ashes (%)	0.79	0.90	0.73	0.31
Vitamin A (IU)	185	146	126	190
Vitamin D (IU)	2.3	0.18	2.0	1.4
Thiamin (mg)	0.068	0.08	0.045	0.017
Riboflavin (mg)	0.21	0.376	0.16	0.02
Niacin (mg)	0.27	0.41	0.08	0.17
Pantotenic acid (mg)	0.31	0.408	0.32	0.20
Vitamin B6	0.046	0.08	0.042	0.011
Folic acid	1.0	5.0	5.0	5.5
Biotin (μg)	1.5	0.93	2.0	0.4
Vitamin B12	0.065	0,712	0.357	0.03
Vitamin C	1.12	4.16	0.94	5.00
Energy (cal/100 ml)	70.00	Nd	69.00	68.00

Source: Jandal*et al.*(1996)

Table 3. Comparison of three types of milk, composición in 100 mL

	Human	Cow	Goat
Protein (g)	1.2	3.3	3.3
Casein (g)	0.4	2.8	2.5
Lactoalbumin (g)	0.3	0.4	0.4
Fat (g)	3.8	3.7	4.1
Lactose (g)	7.0	4.8	3.8
Calorific value (Kcal)	71	69	76

Source: CAPRAHISPANA (2011)

Table 4. Mineral contents in cow´s and goat´s milk(100 g)

Component	Goat	Cow
Ca (mg)	134	122
P (mg)	121	119
Mg (mg)	16	12
K (mg)	181	152
Na (mg)	41	58
Cl (mg)	150	100
S (mg)	28	32
Fe (mg)	0.07	0.08
Cu (mg)	0.05	0.06
Mn (mg)	0.032	0.02
Zn (mg)	0.56	0.53
I (mg)	0.022	0-021

Source: Park (2006)