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ORIGINAL PAPER

Review on Goat Milk Bioactive Lipid and Nutritional Value

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ABSTRACT

A well-balanced diet of the modern population includes increased consumption of products from goat's milk, which has a composition different from the commonly used cow milk. Goat's milk is characterized by better digestibility and a higher buffer capacity than cow's milk. Goat's milk fat is an emulsion of smaller fat globules than a cow's. It doesn't have agglutinin, which clumps fat globules as milk cools. Goat's milk fat has more mono and polyunsaturated fatty acids than cow's milk, making it more nutritious. Goat milk has more short-chain fatty acids than cow milk. Goat's milk products should be part of a healthy, balanced diet due to its unique and beneficial features.

Keywords: Goat milk, bioactive lipid, nutritional, health impact.

INTRODUCTION

As science progressed and consumers became increasingly concerned about their health and health-related foods, a new field of research involving bioactive or biogenic substances, such as bioactive peptides in foods, arose. In 1950, bioactive peptides (BPs) were identified; he revealed the effects of casein (CN) derived phosphorylated peptides on the vitamin D-independent bone calcification of rachitic newborns. Due to the fast-growing understanding of physiologically and functionally active peptides generated from a parent protein source, dietary proteins have gained increasing value over the past two decades. BPs are characterized as unique protein fragments that have a beneficial effect on body function or condition and may eventually impact health. BPs can be given to people through traditional foods, dietary supplements, functional foods, and medicinal

foods. Within the sequence of the parent protein, BPs are inactive and can be released in three ways: 1) through hydrolysis by digestive enzymes, 2) through hydrolysis of proteins by proteolytic microbes, and 3) by the action of proteolytic enzymes produced from microorganisms or plants. In Japan, the claim of BPs was defined as Food for Specified Health Use (FOSHU) in 1991, and the United States introduced the concept of BPs as health claims for foods with the ability to prevent disease in 1993.

Mammalian milk contains a diverse mix of secretory components with different chemical and functional activities. The protein component contains many serum and glandular-derived species with different molecular sizes, concentrations, and functions. the study of these bioactive components in human or other species' milk has been challenging. It has been suggested that caprine milk is a great alternative to cow's milk, especially for people who have a cow milk allergy (CMA). By providing daily necessary proteins and minerals, such calcium and phosphate, to the people of underdeveloped nations where cow milk is not easily accessible, caprine milk has played a significant role in the nutritional and economic well-being of humanity. Goat milk is said to have certain physiologically active qualities that distinguish it from cow or human milk, including high digestibility, distinct alkalinity, high buffering capacity, and specific therapeutic benefits for human nutrition. Although many studies on BPs and/or bioactive substances in human and bovine milk and/or their products have been carried out recently and reported, the research on other species' milk, including goats' milk, has not been thoroughly studied. The bioactive chemicals found in caprine milk are discussed in this chapter in terms of their many natural forms, the physiological, nutritional, and biochemical functions they serve for human health, as well as possible uses and manufacture.

GOAT MILK CHARACTERISTIC

Goat's milk is becoming more and more popular because it's easier to digest and has more protein, phosphorus, and calcium than cow's milk. Also, more and more people are having problems digesting cow's milk because their guts can't handle it. Goat's milk is made up of the same kinds of chemicals as cow's milk. Table 1 shows the amount of each nutrient in goat's milk and sheep's milk.

Table 1. Chemical composition of particular types of milk (%)

	Cow	**Goat**	**Sheep**
Fat	3.70	4.25	7.98
Protein	3.50	3.52	3.81
Lactose	4.90	4.81	4.87
Mineral components	0.70	0.86	0.90
Dry matter	12.80	13.00	2.029
- (Biadała et al., 2017)			

Goat's milk and cow's milk don't have very different physical properties (Table 2). Cow's milk has a lower iodine value than goat's milk, which means that goat's milk has more unsaturated fatty acids than cow's milk (Wang et al., 2016). Cow milk has lower saponification and a higher refractometric index (Biadała et al., 2017).

Table 2. Physical properties of goat, sheep, and cow milk

	Cow	Goat	Sheep
Active acidity (pH)	6.5-6.7	6.08-7.06	6.6-6.8
Refractometric index (nD^{20})	1.334	1.450	1.349
Iodine value (gI/100g)	27.09	30.44	30.52
Saponification value (mgKOH/1g)	232	228	240
Conductivity (Ω/cm)	0.0040	0.0068	0.0037
Size of casein micelles (nm)	175	260	193
Freezing point (°C)	-550	-556	-570
	- (Biadała et al., 2017)		

BIOACTIVE LIPID COMPONENTS IN GOAT MILK

There are several lipid components that have bioactive functions, such as short and medium-chain fatty acids (MCT), phospholipids, cholesterol, gangliosides, and glycolipids, etc. Triglycerides, which are found in the fat globule, make up 98–99% of milk lipids. The last 1-2% is made up of smaller amounts of lipids, such as diglycerides (0.3–1.6%), monoglycerides (0.002–0.1%), phospholipids (0.2–1.0%), cerebrosides (0.01%–0.07%), sterols (0.2–0.4%), and free fatty acids (0.1–0.4%). As we talked about in the section about the health benefits of goat milk, caprine milk has smaller fat globules than cow milk. This makes caprine milk fat easier to digest and more efficient for lipid metabolism than cow milk fat. Short and medium-chain fatty acids in goat milk help with digestion, lipid metabolism, and the treatment of lipid malabsorption syndromes, among other things. In the next sections, we'll talk more about the important bioactive lipid parts of goat milk.

1. Short and Medium Chain Fatty Acids in Goat Milk

Goat milk fat may contribute to human nutrition in three ways due to its high content of species-specific short-chain and medium-chain triglycerides (MCT):

1) Because lipase targets ester connections of short or medium-chain fatty acids more easily than those of longer chains, goat milk fat may digest faster than cow milk fat.

2) These fatty acids give developing youngsters energy through their unique metabolic capacities and have favorable effects on cholesterol metabolism, such as hypocholesterolaemia action on tissues and blood by inhibiting cholesterol accumulation and dissolving the cholesterol in gallstones.

3) They also treat malabsorption in individuals with steatorrhea, chyluria, hypolipoproteinaemia, intestinal resection, cardiac bypass, infantile epilepsy, premature infant feeding, cystic fibrosis, and gallstones.

2. Phospholipids

Phospholipids are important for the cell membranes of plants, animals, and humans. They work to make cell membranes work by interacting with metabolites, ions, hormones, antibodies, and other cells. Polar phospholipids comprise 1.6% of all lipids. Glycolipids comprise 16% of goat milk's polar lipid fraction. Only 6% of cow milk contains them. The quantitative examination of goat milk's phospholipid fraction of bound lipids revealed 35.4% phosphatidyl-ethanolamine (PE), 3.2% PS, 4.0% PI, 28.2% PC (lecithin), and 29.2% sphingomyelin (SP). Phospholipid fractions are similar between species, but goat milk has somewhat more PE, SP, and PS than cow milk (Table 1). PS, PC, and SP are lower in goat milk than human milk.

Bioactively, phospholipids bind fat globules in a membrane to speed up absorption. Phospholipids remove liver fat by lipotropic action. In their rats' diets, phosphatidyl-ethanolamine lowered serum cholesterol, whereas lecithin did not. They examined how the liver's phospholipid subclasses were distributed and discovered that PC altered the fatty acid contents of both hepatic and plasma phospholipids (lecithin). More than 90% of PC (lecithin) is absorbed by the intestinal mucosa and added to chylomicrons. It's then taken up by HDL. HDL values increased but total cholesterol and triglycerides were unchanged. In healthy participants, oral PC reduced platelet lipids and cholesterol, according to the same scientists.

Brain, nerve tissue, heart muscle, liver, and sperm contain phospholipids. Even though the body can produce PC, researchers are curious in how lecithin improves learning and memory in animals and humans. Caprine milk phospholipids may have similar bioactivities to bovine milk phospholipids.

Table (1). Distribution of phospholipid subclasses in goat, cow, and human milk

Phospholipid Fraction	Present of Total Phospholipids (%)		
	Cow Milk	Goat Milk	Human Milk
Phosphatidyl choline	30	28.2	29
Phosphatidyl ethanolamine	35	35.4	32
Phosphatidyl serine	2	3.2	4
Phosphatidyl inositol	5	4.0	5
Sphingomyelin	24	29.2	29
		- (Kuma *et al.,* 2016)	

3. Conjugated Linoleic Acid

Conjugated linoleic acid (CLA) has received a great deal of interest from nutritionists, food consumers, and researchers in recent years because it has a lot of good effects on human health, such as preventing cancer and heart disease, boosting the immune system, boosting growth, and reducing body fat, among other things. The name "CLA" is a generic name for all positional and geometric isomers of linoleic acid ($C_{18:2}$) that have two double

bonds that are joined together. cis-9, trans-11-octadecadienoic acid is the most biologically active form of CLA. It makes up more than 82% of all CLA isomers in dairy products.

CLA is a bioactive part of goat milk that is thought to be important. Most of the time, milk fat has the most CLA and the most vaccenic acid (physiological precursor of CLA). According to several reports, the average total CLA content appeared to decrease in the following order: 1.08 in ewe milk fat, 1.01 in cow milk fat, and 0.65% in goat milk fat. The season, the stage of lactation or the method of feeding the animals are not mentioned in this report. A study on cow milk showed that goat milk with more CLA comes from goats that only eat grass. The amount of CLA in the milk of different ruminant species changed with the season, mostly because of changes in how they ate. The CLA content in ewe milk changed the most from season to season, going from 1.28% in summer to 0.54% at the end of winter. It showed that feeding Alpine milking goats canola oil at 2 and 4% of their grain intake increased the amount of CLA in their milk by 88 and 210%, respectively, compared to the control group that wasn't given any treatment. Even though there are many things that can change the amount of CLA in dairy products, feeding strategies for animals, especially those that add seeds or oils to their diets that are high in PUFA, have shown to be very effective at increasing the amount of CLA in goat, sheep, and cow milk. If you change your diet to get more CLA, milk fat will have less saturated fat and more monounsaturated fat (like vacenic acid) and polyunsaturated fat (PUFA).

4. Cholesterol

The major sterol in milk is cholesterol (300 mg/100 g of fat, or 10 mg/100 mL of bovine milk). Sterols represent a minor component of total lipids in milk. Cholesterol is mostly distributed in the membrane of fat globules, where it accounts for 0.4% to 3.5% of membrane lipids. The majority of the cholesterol in milk is free cholesterol (85–90%), whereas a little amount is esterified and typically combines with long-chain fatty acids. The mean cholesterol contents of goat, cow and human milk were 11, 14, and 14 mg/100 g, respectively, demonstrating that goat milk contains less cholesterol than other types of milk, but goat milk typically includes more total fat than cow milk. Since cholesterol is associated with coronary heart disease, the reduced cholesterol content of goat milk may be beneficial to human nutrition. In this way, cholesterol in milk can be regarded as a bioactive molecule. Cholesterol levels in goat milk are typically between 10 and 20 mg/100 mL.

According to the fatty acid composition of cholesterol esters, goat milk cholesterol esters include a larger proportion of palmitic and oleic acid than their cow counterparts. Cholesterol esters of cow milk fat account for approximately one-tenth of the sterol content of cow milk. 66% of the free cholesterol and 42% of the esterified cholesterol are bound to goat milk fat globules on average. Comparable to that cow milk, goat milk contains 24 mg/100 mL or 46 mg/100 g fat of unsaponifiable substance. The cholesterol level of different breeds varied greatly, and the majority of cholesterol in goat milk was in free form, with only a minor amount in ester form, 52 mg/100 g fat. Cholesterol is primarily produced in the liver via acetyl coenzyme-A form acetic acid. As a structural

component of cellular and subcellular membranes, plasma lipoproteins, and nerve cells, it serves vital functions in the body. Cholesterol is a metabolic precursor of bile acids and steroid hormones, including vitamin D, and it is necessary for the metabolic systems involved in DNA synthesis and cell division. Cholesterol also plays a crucial role in lipid transport. The body produces 1-4 g of cholesterol per day, and the total quantity of cholesterol in the human body is 100-150 g, with 10-12 g always present in the blood. A greater amount of cholesterol is generated within the body that is ingested, indicating that there is no link between cholesterol consumption and blood cholesterol levels. Since the body has a compensating regulatory system for blood cholesterol levels, a rise in dietary cholesterol and biliary cholesterol excretion reduce endogenous cholesterol production. After consuming cholesterol, the hepatic export of cholesterol in low-density lipoproteins (LDL) or their precursor increases.

Nutritional and therapeutic Properties of Goat Milk

Dietary proteins derived from animals or plants can be an abundant source of physiologically active peptides. Once bioactive peptides are released by digestion or proteolysis, they may have various physiological effects on the gastrointestinal, circulatory, endocrine, immunological, and neurological systems of the organism. However, the original macromolecular proteins, such as cow milk caseins and whey proteins, might trigger allergic reactions in certain people. On the other hand, goat milk has been recognized for its hypoallergenic and therapeutic capabilities in human nutrition and health, suggesting that caprine milk may include distinct bioactive and metabolically active components.

CMA is a common disease in infants; however, its etiologic processes are unclear. Caseins and beta-lactoglobulin (MW 36,000), the primary whey protein in cow milk that is absent from human breast milk, are primarily responsible for cow milk allergy. It has been hypothesized that increased gastrointestinal absorption of antigens followed by unfavourable local immune reactions may be a significant etiological role in the development of food allergies such as CMA. The prolonged exposure of infants with CMA to cow milk was related to an inflammatory reaction in the lamina propria of the intestinal membrane. Even in the absence of milk antigen, this inflammatory response might occur due to a continual increase in macromolecular permeability and electrogenic activity of the epithelial layer. The clinical manifestations of CMA are temporary, as all illness markers revert to normal after many months on a diet free of cow's milk.

Infants and allergy patients who are allergic to cow milk or other food sources have been prescribed goat milk as a substitute for cow milk. There is substantial empirical and anecdotal evidence for goat milk's potential as a natural, hypoallergenic, and bioactive dairy food source for human nutrition and health.

CONCLUSION

The annual global production of goat's milk is approximately 16 million tonnes, increasing interest in products derived from goat's milk, which has a different composition than cow's milk, has emerged from the modern population's increased

dietary awareness and rationality. Goat's milk is more easily digestible and has a greater buffering capacity than cow's milk.

In addition, the fat in goat's milk is in the form of an emulsion composed of fat globules with a smaller diameter than those in cow's milk. It does not include the enzyme agglutinin, which causes the fat globules in chilled milk to clump together. Goat's milk fat includes more mono and polyunsaturated fatty acids than cow's milk fat, resulting in this milk's superior nutritional qualities. Additionally, goat's milk has more short-chain fatty acids than cow's milk. In conclusion, goat's milk products should be a significant element of a healthy and well-balanced daily diet due to their distinctive and useful features.

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