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## Goat milk composition and nutritional value: A review

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### Abstract

Goat milk is one of the earliest known super foods as goats were the first farm animals to be domesticated. Goat milk is nutritionally closest to cows' milk yet it has certain physical properties that set it apart, which may impact on digestibility and health. Dairy goats have minimal maintenance, general administration, and feeding costs. So, rearing of goats is quite easier than other dairy animals. Caprine milk is thicker and creamier than cow milk or plant milks, and goat milk has more nutrients that may offer health benefits. Goat milk is also an excellent source of vitamin A, is high in digestible protein, contains significantly lower levels of alpha-S1-casein, contains slightly less lactose, and has more oligosaccharides (non-digestible carbohydrates) than cows' milk. This load of nourishing components gets easily assimilated by the human body. Higher selenium content in goat milk brings about platelet recovery when experiencing dengue fever. Sialic acid present in goat milk is also reported to help fast brain development. Packed with vitamins and minerals, this alternative to cow's milk is gentler on the stomach and provides a solution for people with lactose sensitivity also. Goat milk is actually considered much closer to human milk than cow's milk. The physiological and biochemical facts of the unique qualities of goat milk are very little known and barely exploited, especially not the high levels of short and medium chain fatty acids, which have recognized medical values for many disorders and diseases of people. Goat milk can be considered as an excellent dairy alternate with the potential to replace traditional dairy products and to improve human health. Due to the significant nutritional benefits, goat milk is widely used to feed more starving and malnourished people in the developing countries than cow's milk. Therefore, there is a need to aware the human population and popularize the use of goat milk by providing knowledge about advantages of consumption of goat milk so that its production and utilization could be enhanced.

**Keywords:** goat milk, nutrition, human health, micro nutrients, composition

### Introduction

Goats were among the first domesticated animals. According to archaeological data, there has been in a symbiotic relationship with man for up to 10,000 years (Ensminger and Parker, 1980) <sup>[11]</sup>. Mostly goats are maintained as a source of the milk. Whereas, a number of the individuals maintain them as a source of the income in terms of meat and milk production. Adaptation of goats in xerophytic area, high stress conditions and low cost maintenance makes it an ideal animal for landless and marginal farmers. Goats are often called poor man's cow, because they give the same benefit as the cow, (i.e., milk, meat) and is cheaper than the cow which makes it affordable for poor and weaker sections of society. In many countries, goat farming is the important part from the economy point of the view; especially in the Mediterranean and Middle East region. Goat farming is well organized in France, Italy, Spain and Greece (Park and Haenlein, 2007) <sup>[25]</sup>. Poor and insufficient volume, focal and seasonal demand of goat milk has been the main reason behind lesser Industrialization of the goat milk. Though there is an increase in the production of goat milk and population of goats across the world, still there is lack of marketing of this milk. As goat milk is rich in mineral and vitamin content and has creamy texture, it is used as the replacer for number of the supplements which people consume daily. Fat globules in goat milk are smaller which makes it easily digestible food as compared to cow milk. Goat milk has been suggested as a promising alternative for cow and human milk (Zenebe *et al.*, 2014) <sup>[33]</sup>. Goat milk has superior digestibility, alkalinity, buffering capacity, and some therapeutic benefits in medicine and human nutrition than cow or human milk (Coni *et al.*, 1999) <sup>[7]</sup>.

The relationship between the structural and functional properties of goat milk and its usage in lowering common milk-related health disorders has been clarified by recent scientific findings.

Presently, India possesses 148.88 million goats which contribute 27.80% of total livestock population of India (20<sup>th</sup> livestock census, 2019). Goat is one of the main contributors of dairy and meat products for rural people, more than any other mammalian farm animal, particularly in developing country. Home consumption is one of the most major factors of goat milk demand. As the world population is increasing, so does this need. The second important aspect of demand for goat milk is the connoisseur interest in goat milk products especially, cheeses and yoghurt in several developed and developing countries. Because people's disposable incomes are rising, this need is also expanding. Another important aspect of demand for goat milk derives from the affliction of persons with cow milk allergies and other gastro-intestinal ailments. This demand is also growing because of a greater awareness of problems with traditional medical treatments to such afflictions among the people, especially in developed countries. Despite the far higher amount of cow milk available, the production of goat milk and its products is often significantly lower, resulting in a higher market price. Production and marketing of goat milk and its products is therefore a key niche in the entire dairy industry sector. Besides providing nutrition to the human body, goat milk has powerful antioxidant, antimicrobial, antiallergic and other nutraceutical properties, which are elaborated in this review.

#### Goat milk - a natural source of complete nourishment

It is nutritionally comparable to cow's milk, since it carries similar amounts of calcium, potassium, phosphorus, and a variety of other nutrients that are beneficial to one's health. Goat milk contains higher levels of six out of the ten essential amino acids (Tomotake *et al.*, 2006) [32].

#### Milk lipid

The most important components of milk in terms of cost, nutrition, physical and sensory characteristics that impart to dairy products are lipids. (Park Y W., 2007) [25]. In goat milk the lipid globules are significantly smaller (both in size and diameter) with an average size of the fat globules < 3  $\mu\text{m}$  as compared to that of the cow milk (Park Y W., 2007) [25]. This is the reason why goat milk is considered as "self-homogenized" milk. The viscosity of milk is regulated by the total fat content and the size and distribution of fat globules, which are essential for the preprocessing and manufacture of milk products. Goat milk is more digestible due to the vast quantity of fat globules with compact diameter. This is because the globules' total surface area is sufficient to adequately bind the lipids (López-Aliaga *et al.*, 2010) [21]. Glycerides and steroids make up to 99 percent of fat. The fat is present in the milk as "oil-in-water" type of emulsion. The lipid content and characteristics of goat's milk fat globules were found to be identical to those of cow's milk, although goat's milk lacked agglutinin. (Jenness, 1980) [14].

#### Milk proteins

Goat milk has a protein content that is nearly comparable to cow milk. An unstable micellar phase made of casein and a soluble phase made of whey proteins are two different phases of milk proteins. When compared to cow milk, goat milk has lower levels of  $\alpha\text{s}$ -casein, larger amounts of  $\beta$ -casein fractions, and about similar quantities of  $\kappa$ -casein fractions. Goat milk also contains equal amount of  $\alpha\text{s}1$ -casein, but the amount and genetic variants differ between goat populations (Diaz-Castro *et al.*, 2009) [9]. The protein in goat milk is

differentiated by the makeup of its individual constituents, high levels of casein and structure of the casein micelle, the wide array of bioactive peptides within these fractions as well as minor proteins and non-protein fraction which includes amino acids, nucleotides and nucleosides. Many of goat milk's physical features and health advantages are determined by its protein composition. In vitro, trypsin hydrolyzed 96 percent of goat casein in comparison to just 76-90 percent of cow casein, according to (Jasinska, 1995). Similarly, human stomach and duodenal fluids destroy goat milk substantially faster than cow milk (Almaas *et al.*, 2006) [2]. The lower levels of s1casein in goat milk are directly connected to the lower allergenicity of goat milk when compared to cow milk, which is a major benefit for newborns who drink goat milk as their primary source of nutrition and for those who are allergic to cow milk. Casein micelles in goat milk differ significantly from those in cow milk in terms of sedimentation rate, solubilization, heat stability, calcium, and phosphorus content (Haenlein, 2004) [12]. The low s1casein level in goat milk makes soft cheeses easier to make, since it allows for faster coagulation and softer curds (Ambrosoli *et al.*, 1988) [3]. Amino acids are a component of the protein fraction as well. With the exception of a lower percentage of cysteine than human milk, goat milk has a comparable amino acid profile to cow and human milk (Silanikove *et al.*, 2010) [31].

#### Minerals

Goat milk has a greater mineral content than human or cow milk, ranging from 0.70 to 0.85 percent (Silanikove *et al.*, 2010) [31]. Goat milk has a greater concentration of calcium and phosphorus than human milk, as well as greater levels of potassium, magnesium, and chloride than cow milk. Although macro-mineral concentrations do not vary so widely, they do vary based on the breed, nutrition, individual animal, lactation stage, and udder health (Park and Chukwu, 1988) [24]. Goat milk includes more zinc and iodine and less iron than human milk in terms of trace minerals. However, goat milk has a greater iron bioavailability than cow milk due to the higher nucleotide content, which aids absorption in the stomach (Raynal-Ljutovac *et al.*, 2008) [28]. The selenium content found in goat milk is also higher than that found in milk of cow (Ednie *et al.*, 2015) [10] and at the same time, is more bioavailable, which can be attributed to the high MCFA content or soluble protein ratio in goat milk (Zenebe *et al.*, 2014) [33]. Fe concentrations in goat and cow milk are much lower than in human milk. Both goat and cow milk have much higher levels of iodine than human milk, which is crucial for human nutrition since iodine and thyroid hormones are involved in the metabolic rate of physiological body processes. Glutathione peroxidase is higher in goat than in human and cow milk. In goat milk, total peroxidase activity (related with glutathione peroxidase) was 65 percent, compared to 29 percent in human milk and 27 percent in cow milk (Debski *et al.*, 1987) [8]. The salt balance in goat milk has a role in the mineral retention in the curd during cheese manufacturing. Goat cheese, for example, retains the majority of its zinc and manganese as it exists with casein, but varied levels of calcium, magnesium, and phosphorus are present in the soluble phase (33 percent, 66 percent, and 39 percent, respectively) and are therefore not kept in the curd (Park *et al.*, 2007) [25].

## Vitamins

Because goats convert all  $\beta$ -carotene from foods into vitamin A in the milk, goat milk has a greater vitamin A concentration than cow milk (Conesa *et al.*, 2008) [6]. Vitamin A is required for innate and adaptive immune responses, such as cell-mediated immunity and antibody responses. The whiter colour of goat milk compared to cow milk is due to the conversion of carotene to retinol (Park *et al.*, 2007) [25]. Goat milk is significantly lower in vitamin E, folic acid, and vitamin B12 than cow milk, which can lead to "goat milk anaemia" if these minerals are not consumed in sufficient quantities (Park *et al.*, 2007) [25]. Vitamin B6 and vitamin D, which are both crucial throughout infancy, are low in both goat and cow milk (Juarez *et al.*, 2011) [16]. Vitamin C is a well-known water-soluble antioxidant present in goat milk in higher concentrations than cow milk. Antiviral and antioxidant characteristics of this vitamin have been shown to alter several aspects of the immune system, including immunity control. Vitamins D, E, thiamine, riboflavin, and niacin are all abundant in goat milk. Goat milk has low levels of foliate (Park, 2006) [26] thus infants fed solely on goat milk are overburdened with these minerals as well as vitamins (Lavigne *et al.*, 1989) [19] found that high temperature short time pasteurisation (HTST) of goat milk was the best processing method for preserving vitamins and extending shelf life of the milk, while some thiamine, riboflavin, and Vitamin C losses occurred.

## Goat milk in curing dengue fever

When compared to cow milk, goat milk contains more than 27% selenium (Belewu and Adewole, 2009) [4]. The main problem with dengue fever is a lack of selenium, which causes a drop in platelet count in the body. Dengue fever is spread by infected mosquitos that carry the virus. These fever-causing viruses are transmitted to humans by mosquito bites. These viruses enter the body through the bloodstream and grow in the glands, contaminating the remaining organs and tissues. The major symptom of dengue fever is a drop in platelet count (Kurane, 2007) [17]. Goat milk is commonly administered to dengue patients to keep their bodily fluid balance. Consumption of goat milk increases biliary cholesterol secretion, lowering plasma cholesterol levels, although phospholipids, biliary acid, and lithogenic levels remain unchanged (López-Aliaga *et al.*, 2010) [21]. In addition, se deficiency causes irreversible cardiomyopathy (Morgan *et al.*, 2010) [23].

## Goat milk in lactose intolerance

Lactose level in goat milk is somewhat lower than in cow milk. Lack of Lactase, an enzyme that digests milk sugar causes Lactose intolerance Lactase is an enzyme that converts lactose to glucose and galactose and is produced by the microvillus membrane of enterocytes (Russell *et al.*, 2011, Hammer and Hammer, 2012) [13, 30]. Undigested lactose can cause gastrointestinal problems such bloating, abdominal discomfort, and diarrhoea if lactase activity is inadequate or absent. Because of the softer curd formation, goat milk is easy to digest. The casein composition of goat milk allows lactose to transit through the large intestine more quickly, preventing lactose intolerance symptoms (Robinson, 2001) [29] hence can be used for preventing symptoms of lactose intolerance.

## Immunity booster

In the functionality of immune system selenium has an

important role. Selenium content of goat milk is significantly higher as compare to co milk. Hence, goat milk and its products are observed to work as immunity booster and have ability to safeguard human health against illness.

Our immune health is influenced by a number of factors and nutrition in particular is major determinant of the body's immune response. Even if goat milk cannot be considered as a perfect alternative for people with cow milk allergy, but few studies have showed immunomodulatory effects from goat milk both in in-vitro and human studies. Recently investigated the effects of goat milk on human blood cells in terms of nitric oxide (NO) and cytokine release, the results demonstrated that goat milk was able to activate NO release from blood cells as well as triggering of cytokine production (IL-10, TNF- $\alpha$  and IL-6). The NO release could have cardio-protective effects in the milk consumer and also expose antibacterial activity and thereby prevent infections.

## Prebiotic supplement

The non-digestible sugars or oligosaccharides present in milk can act as a prebiotic. Prebiotics has an important role in maintaining the health of the gastrointestinal tract by selectively promoting the growth of beneficial gut micro biota and halting the growth of pathogenic bacteria. Oligosaccharides present in human milk are known to be beneficial components due to their prebiotic and anti-infective properties (Boehm and Stahl, 2007) [5]. Most oligosaccharides (more than 95%) from human milk are resistant to digestion, implies that their main target is the GIT of the neonate, where they are utilized by intestinal bacteria. Goat milk typically contains between 250 to 300 mg/l oligosaccharides, 4-5 times higher than the content present in cow milk. The oligosaccharides found in goat's milk have been shown to reduce intestinal inflammation and aid recovery from colitis in animals (Lara-Villoslada *et al.*, 2006) [18].

## Treatment of cancer, allergy and others

Proteins are the most prevalent antigens found in foods. With a 2-6 percent prevalence, milk is one of the most prevalent food allergens and the most prevalent sensitivities in young infants. Due to its diverse protein structure, notably its caseinmicelle components, goat milk is a significantly less allergic alternative than cow milk, according to several studies and anecdotal data. Conjugated linoleic acid (CLA) is abundant in goat milk (Jirillo *et al.*, 2010) [15], CLA has been shown to exhibit anti-carcinogenic characteristics in animal models of mammary and colon cancer (Liew *et al.*, 1995) [20], as well as in vitro models of human melanoma, colorectal and breast cancer. Allergies can be acute or chronic in nature, their symptoms ranging in severity from non-life threatening reasons such as eczema, rhinitis and digestive problems to very serious life threatening reasons including anaphylaxis, bronchospasm and urcaria (Mc Cullough, 2003) [22].

## Conclusion

Goat milk has a good biocompatibility of proteins, lipids, vitamins, and minerals, making it ideal for newborn diets. In terms of nutritional value and health impacts, goat milk's unique characteristics have been well examined. The improved digestibility, correct fatty acid and protein composition, and bioactive component concentration of goat milk seems to make it beneficial for treating or preventing certain medical problems. Goat milk should be encouraged in developing nations like India, where malnutrition and



illnesses are more widespread, as well as high poverty levels, due to its high nutritious content and physiological qualities. The expense of upkeep, general care, and feeding are all factors to consider. Dairy goats have minimal maintenance, general administration, and feeding costs. However, in developing nations, goat milk is still underutilized and commercialized. And there is a scarcity of information on its commercialization in the scientific community. It is necessary to raise community knowledge about the importance of goat milk for its nutraceutical properties to improve goat breeds in order to enhance milk production and to undertake further studies and research on goat milk

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