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Review Paper / Derleme Makale

Nutritional and Health Aspects of Goat Milk Consumption

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ABSTRACT

Goat milk has become more popular world-wide in recent years. This new interest could be partially explained by the unique sensorial properties of goat milk products, which are characterized by a specific and typical 'goat' flavour. Goat milk differs from bovine milk in a number of ways. It has more free amino acids, and its unique casein precipitates more readily into finer particles than cow milk. The higher amounts of short-chain fatty acids present are partially responsible for the distinct flavour of goat milk. It is reported that the bioavailability of Zn is enhanced by goat milk in comparison to cow milk. Also goat milk has high carnitine content, and is distinguished by its high chloride and potassium contents. Several characteristics of goat milk are currently the focus of increased research interest. In this study, advantages and disadvantages of goat milk consumption were reviewed.

Keywords: Milk, goat milk composition, goat milk products, milk allergy

Keçi Sütü Tüketiminin Beslenme ve Sağlık Üzerine Etkileri

ÖZ

Keçi sütü dünya çapında giderek daha popüler hale geliyor. Bu yeni ilgi kısmen tipik 'keçi' lezzetinden ve keçi sütü ürünlerinin duyusal özelliklerinden kaynaklanmaktadır. Bununla beraber keçi sütünün, sığır sütünden ayrılan önemli özellikleri vardır. Serbest aminoasitleri daha fazladır ve kazein daha ince parçacıklar halinde inek sütünden daha kolay çöker. Kısa zincirli yağ asitlerinin daha yüksek miktarlarda olması kısmen keçi sütündeki farklı aromayı oluşturur. Ayrıca keçi sütü yüksek karnitin içeriği ve yüksek klorür ve potasyum içeriği ile ayırt edilir. Keçi sütü çeşitli özellikleri ile şu anda artan araştırma ilgi odağı haline gelmiştir. Bu derlemede keçi sütü tüketiminin avantajlı ve dezavantajlı yönleri üzerine yapılan çalışmalar bir araya getirilmiştir.

Anahtar Sözcükler: Süt, keçi sütü bileşimi, keçi sütü ürünleri, süt allerjisi

INTRODUCTION

Human beings try to find new alternatives of foods and researchers conduct studies for more and healthier foods. The milk of different ruminant species, either directly or as dairy products, comprises a food of outstanding importance for humans throughout their lives [1]. Goat and sheep milk is widely used for home consumption worldwide and used to produce different cheeses and yoghurt. There is much historical information about consuming goat milk. Herding of goats is thought to have evolved about 10.000 years ago in the mountains of Iran, making goats one of the oldest domesticated animals [2]. Goat milk, and the cheese made from it was venerated in ancient Egypt with some Pharaohs supposedly placing these foods among the other treasures in their burial tombs [3]. In their study, Ribeiro and Ribeiro [4] mentioned the use of goat's milk as an excellent food source. The top producers of goat milk in 2008 were India (4 million metric tons), Bangladesh (2.16 million metric tons) and the Sudan (1.47 metric tons.) [5]. The Mediterranean region

produces 18% of the world's supply of goat milk [6]. According to information given by FAO [7], the goat is believed to be the first true livestock domesticated and world goat milk production reached 15.2 million tons in 2008 most of it being used by households or families. Europe produces only 2.5% of the world goat milk, but it is the only continent where goat milk production has significant economic importance and organization. In this study I tried to gather all advantageous and disadvantageous aspects of goat milk consumption and characterization. On the other hand, there is a lack of available data which is reported in recent years regarding the composition of differences from other mammalian milks. Why the reason of that, some of the older studies evaluated in this review.

WHY DO HUMANS NEED or WANT to CONSUME GOAT MILK?

Haenlein [8, 9] approached the key question: "Why goat milk?" This is a critical question to be asked and answered by all who focus on goats' milk researches and are trying to help establish a dairy goat industry. The same author also asked: Why buy goat milk? 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. According to Haenlein [9], Park and Haenlein [10] there are three reasons for demand of goat milk. The first one is home consumption. The second aspect is the connoisseur interest in goat milk products, especially cheeses and yoghurt in many developed countries. The third aspect derives from a medical purpose, on the affliction of people with cow milk allergies and other gastrointestinal ailments. As Ozawa et al. [11] mentioned, gourmet food connoisseurs are willing to pay high prices for certain goat milk products that are often imported into Japan. As Ribeiro and Ribeiro [4] concluded, connoisseurs and gastronomy chefs look for goat milk products, because of their flavour, texture and diversity. On the other hand, cheeses made from goat's milk are generally whiter in color because goats are able to convert b-carotene into vitamin A and also produce milk with smaller diameter fat globules compared to that produced by cows [12]. The processed goat milk specialty products are expected to have a good market prospect. According to conclusion of the study performed by Tranjan et al. [13], the goat flavoured beverages showed good potential for commercialization, serving as an additional alternative for the introduction of products made from goat's milk, into the market, with a minimal increase in costs for the dairy plant. 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 [14]. Goat milk also has a great potential in expanding its horizon into beauty, skin care and cosmetic markets.

NUTRITIONAL ASPECTS and COMPOSITION of GOAT MILK

The composition of cow milk is expected to have minimal changes throughout the year, because the milk entering bulk tank from the cow herds would vary little by seasons because of year-round breeding [15]. There are many advantageous aspects for goat milk composition. Under this topic I tried to review nutritional value and composition of goat milk and differences of composition between cows' and goat's milk.

Protein

As a result of the study performed by Ceballos et al. [1]; goat's milk contains a somewhat lower amount of caseins and so its proportion of serum proteins is higher. This aspect is the first reason normally given to explain the greater digestive utilization made of goat milk protein than of cow milk protein. This observation is similar as reported by Park [16]. Concerning the contents of each amino acid per 100 g of milk, Ceballos et al. [1] concluded that except for the quantities of tyrosine and serotonin, in which cases the differences were not statistically significant, those of all the other amino acids were higher in goat milk than in cow milk. As concluded by another study, goat milk contains a similar amino acid profile to cow and human milk except for a lower concentration of cysteine [17]. As Silanikove et al. [18] reported goat milk is a valuable source of taurine for the human neonate and the adult. If it is needed to touch on other non-protein nitrogen components, nucleotides and polyamines have to be mentioned. Nucleotides (Nu) are assumed to facilitate immune maturation of the milk-fed offspring and are often added to infant formulas. Goat milk, in contrast with cow milk, also contains a complex array of Nu. The Nu content of infant formula made from goat milk approaches the same levels as human milk without the need for additional Nu [19]. Polyamines was shown to be important for optimal growth, gastrointestinal tract (GIT) cell function, maturation of GIT enzymes and have been implicated in reducing the incidence of food allergy in infants [20]. Ploszaj et al. [21] found that goat colostrum and milk are rich in polyamines, highest compared to milk of other mammals (e.g., human, rat, sow, and cow). As a conclusion of these findings, goat milk appears to be an excellent source of Nu and polyamines for infant and follow-on formulas and has the potential to be a good source of polyamines [18, 20].

Carbohydrate

Oligosaccharides, which are common carbohydrates, are considered to be beneficial components of human milk due to their prebiotic and anti-infective properties [22]. Recently, oligosaccharides from goat milk were characterized goat milk typically contains between 250 and 300 mg/L oligosaccharides, 4–5 times higher than the content in cow milk and 10 times higher than that of sheep milk, but still much lower than in human milk, at 5–8 g/L. The oligosaccharides in goat milk are complex, with a profile most similar to human milk, in comparison to cows and sheep. Thus, goat milk appears to be an attractive natural source of human-like oligosaccharides for infant, follow on, and health-promoting formulas, due to its composition and content [23].

Fat

The results of the study of Ceballos et al. [1] show that goat milk has a 40% higher content of medium-chain fatty acids than cow milk. When the values are expressed as mg/100 g of milk, the difference rises to as much as 115%. The total proportion of CLA in goat milk, in the study of Ceballos et al. [1], was 62% higher than that in the cow milk. Díaz-Castro et al. [24, 25] reviewed that goat milk fat is of higher nutritional quality than cow milk since it is richer in medium chain triglycerides (MCT) and has higher carnitine content. These lipids increase the energy production derived from fatty acids there by limiting the availability of substrates for lipid peroxidation when consuming goat milk.

Vitamin and mineral

Mineral contents of goat and sheep milk are much higher than those of human milk. Goat milk contains about 134 mg Ca and 121 mg P/100 g while human milk has only one-fourth to one-sixth of these two major minerals. Overall, goat milk has more Ca, P, K, Mg and Cl, and less Na and S contents than cow milk. Goat and human milk contain higher levels of Se than cow milk [26]. The levels of Ca, P, Mg, Fe and Cu in the goat milk ash were observed significantly higher than those in the cow milk ash as a result of the study of Ceballos et al. [1]. When these values were expressed as mg/100 g of milk, all except that of Zn were also higher in goat milk. Nowadays, the better nutritional quality of goat milk compared to cow milk, on the basis of its mineral composition, is considered to result not just from the minerals provided by each, but also from the body's utilization of them, in both digestive and metabolic processes. Díaz-Castro et al. [24] reported that the bioavailability of Zn is enhanced by goat milk when compared to cows' milk. Nestares et al. [27] reported the beneficial effect of goat milk consumption on Fe metabolism. As Underwood [28] reported goat milk contain significantly greater iodine contents than human milk. Goat milk supplies adequate amounts of Vitamin A and niacin, and excesses of thiamin, riboflavin and pantothenate for a human infant [29]. If a human infant fed solely on goat milk, the infant is oversupplied with protein, Ca, P, Vitamin A, thiamin, riboflavin, niacin and pantothenate in relation to then FAO-WHO requirements.

HEALTH ASPECTS of GOAT MILK

Other than nutritional advantages, demand for goat milk derives from a medical purpose, on the affliction of people with cow milk allergies and other gastrointestinal ailments [4]. 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 related by Wu et al. [30], who called goat milk a feasible nutraceutical for gastrointestinal disorders. It is easier to digest than cows' milk and may have certain therapeutic value [9]. According to Park and Haenlein [10], 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. Lopez-Aliaga et al. [31] 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. Results of the study performed by Lara-Villoslada et al. [32] suggest that oligosaccharides from goat milk play important roles in intestinal protection and repair after a damage caused by DSS-induced colitis.

The higher proportion of medium-chain fatty acids in goat milk are known to: (i) be anti-bacterial, (ii) be antiviral, (iii) inhibit development and dissolve cholesterol deposits, and (iv) be absorbed rapidly from the intestine [33]. The greater bone density in the goat milk-fed piglets may have been due to the greater concentrations of plasma minerals, reflecting a better uptake of minerals. In addition, goat milk was found to be advantageous over bovine milk because it sustained high calcium availability without restriction of iron utilization, as is frequently the case with bovine milk [27]. According to some authors, goat's milk can be consumed without negative effects for people suffering cow milk allergy. This is one of the reasons highlights the market potential of goat milk. However, symptoms of allergy to goat milk appeared at a much later age than cow-milk allergy [34], which may benefit younger infants who are dependent on milk as their main source of nutrients. In addition, allergy-related symptoms to goat milk may develop in individuals who have already developed an allergy to cow milk. Bevilacqua et al. [35] suggested that the reduced allergenicity of goat milk might be directly related to the lower levels of αs1-casein. There are many other case reports evaluating the allergy to goats' milk.

WHY HUMANS DON'T PREFER TO CONSUME GOAT MILK?

An important question was asked in review of Raynal-Ljutovaca et al. [36]: "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 [36]. There are a few reasons which make consumers avoid consuming goat milk and milk products. According to the questionnaire performed by Ozawa et al. [11], the current existence of goat milk in Japan can be defined as 'forgotten'. Only 10% of Japanese households recognize that goat milk and its related products are commercially available and only 30% of middle-aged adults have experienced drinking goat milk. More than 70% of respondents who had never consumed goat milk expressed a desire to try it. A possible problem of "goaty" and "mutton" flavour in goat milk and products can pose a challenge to manufacturers and bring limitations to consume as drink or milk product [26]. Queiroga et al. [37] declared thatthe flavor of this milk is particular and stronger than cow's milk, which constrains its acceptability among several consumers. As a rule, such products from goat milk are

more expensive than similar products derived from bovine and ovine milk [38]. Actually also in Turkey, the price of goat milk and products is high neither and customer consuetudes, industrial interest are low. Low daily volume, even of herd bulk milk may be one of the reasons for the difficulty in establishing an efficient processing industry of goat and sheep milk in many countries. Compared to cow milk, goat milk has significant deficiencies in folic acid and Vitamin B12, which cause "goat milk anemia". Levels of folate and Vitamin B12 in cow milk are five times higher than those of goat milk [39, 40]. Goat and cow milk are both deficient in pyridoxine (B6), Vitamins C and D, and all these deficient vitamins must be supplemented to baby nutrition from other sources [41]. Levels of Fe in goat milk are significantly lower than in human milk [16]. Lactose content of goat milk is about 0.2–0.5% less than that of cow milk [42]. Goat milk does contain less lactose than cow milk (on average, 4.1% vs. 4.7%), but cannot be regarded as a dietary solution to people suffering from lactose intolerance [2].

CONCLUSION

According to the conclusion of this review, the connoisseur interest for goat milk is growing and medical purposes such as prevention allergy to cow milk, cause more goat milk consumption. If a human infant fed solely on goat milk, the infant is oversupplied with protein, Ca, P, Vitamin A, thiamin, riboflavin, niacin and pantothenate in relation to then FAO-WHO requirements. On the other hand, there is a lack of knowledge and inability to utilize milk in forms conducive to human consumption. A possible problem of "goaty" and "mutton" flavour in goat milk is another disadvantage. Goat milk and such products from goat milk are more expensive than similar products derived from bovine and ovine milk. Compared to cow milk, goat milk has significant deficiencies in folic acid and Vitamin B12, which cause "goat milk anemia". The beneficial effect of goat milk consumption on Fe metabolism was reported however levels of Fe in goat milk are significantly lower.

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