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Review Article

Bioactive Properties of Goat Milk: It's Hypoallergenic, Nutritional and Therapeutic Significance: A Review

Aleme Asresie[1,*] and Mulugojjam Adugna[2]

[1]College of Agriculture and Environmental Sciences, Department of Animal Sciences, Adigrat University, Adigrat, Ethiopia
[2]College of Natural and Computational Sciences, Department of Biology, Debretabor University, Debretabor, Ethiopia

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Corresponding Author:
Aleme Asresie
almasres06@gmail.com

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ABSTRACT

This paper reviewed researches on bioactive properties of goat milk: it's hypoallergenic, nutritional and therapeutic significance. Dietary proteins of animal or plant foods can provide rich sources of biologically active peptides. Once bioactive peptides are liberated by digestion or proteolysis, they may impart in the body different physiological effects on the gastrointestinal, cardiovascular, endocrine, immune, and nervous systems. However, the original macromolecular proteins such as cow milk caseins and whey proteins can cause allergic responses to certain individuals. Goat milk, on the other hand, has been known for its hypoallergenic and therapeutic properties in human nutrition and health, suggesting that Caprine milk may possess certain bioactive and metabolically active components that may be unique to this species' milk. Considering the bioactive components in milk, the hypoallergenic properties of goat milk are of great importance to human health and medicine. This premise has been of continuous keen interest to goat milk producers and consumers, especially in recent years in developed countries. Goat milk also exhibits significant nutritional and therapeutic functions in abnormal or disease conditions of human nutrition and health, due mainly to some of its biologically active compounds. Goat milk recommended as a "useful alternative to cow milk" because Caprine milk apparently has certain growth factors and bioactive components, which may not be equally available in bovine milk.

Keywords: Bioactive properties, goat milk, hypoallergenic, therapeutic significance.

INTRODUCTION

Dietary proteins of animal or plant foods can provide rich sources of biologically active peptides. Once bioactive peptides are liberated by digestion or proteolysis, they may impart in the body different physiological effects on the gastrointestinal, cardiovascular, endocrine, immune, and nervous systems (Korhonen and Pihlanto, 2007). However, the original macromolecular proteins such as cow milk caseins and whey proteins can cause allergic responses to certain individuals. Goat milk, on the other hand, has been known for its

hypoallergenic and therapeutic properties in human nutrition and health, suggesting that Caprine milk may possess certain bioactive and metabolically active components that may be unique to this species' milk. Cow milk allergy (CMA) is a frequent disease in infants, although its etiologic mechanisms are not clearly defined (Heyman and Desjeux, 1992; Park, 1994; Park and Haenlein, 2006). Caseins as well as beta–lactoglobulin which is the major whey protein cow milk, not found in human breast milk, are mostly responsible for cow milk allergy (Heyman *et al*., 1990 ; Park, 1994). It has been suggested that increased gastrointestinal absorption of antigens followed by adverse local immune reactions may contribute to a major etiological factor in development of food allergies like cow milk allergy (CMA) (Walker, 1987). Infants afflicted with cow milk allergy (CMA) were associated with an inflammatory response in the *lamina propia* of the intestinal membrane by prolonged exposure to cow milk.

Such inflammatory response also can occur by a constant increase in macromolecular permeability and electrogenic activity of the epithelial layer, even in the absence of milk antigen (Robertson *et al*., 1982; Heyman *et al.,* 1988). The clinical symptoms of cow milk allergy (CMA) are transient, since all disease parameters return to normal after several months on cow milk–free diet (Heyman *et al.,* 1990). Goat milk has been recommended as the cow milk substitute for infants and allergic patients who suffer from allergies to cow milk or other food sources (Rosenblum and Rosenblum, 1952; Walker, 1965; Van der Horst, 1976; Taitz and Armitage, 1984; Park, 1994; Haenlein, 2004). There has been much documented and anecdotal evidence for the potential of goat milk as an effective natural, hypoallergenic, and bioactive dairy food source for human nutrition and health. Therefore, this manuscript Endeavour's to present a detailed discussion on bioactive properties of goat milk: it's hypoallergenic, nutritional and therapeutic significance.

Hypoallergenic properties of goat milk

Considering the bioactive components in milk, the hypoallergenic properties of goat milk are of great importance to human health and medicine. This premise has been of continuous keen interest to goat milk producers and consumers, especially in recent years in developed countries (Park and Haenlein, 2006). In a recent study, treatment with goat milk resolved significant numbers of cases of children who had cow milk allergy problems; and in another allergy case study, 49 of 55 treated children benefited from the treatment with goat milk (Bevilacqua *et al*., 2000). Various anecdotal literature has shown that goat milk has been used for hypoallergenic infant food or milk substitute in infants allergic to cow milk and in those patients suffering from various allergies such as eczema, asthma, chronic catarrh, migraine, colitis, hay fever, stomach ulcer, epigastric distress, and abdominal pain due to allergenicity of cow milk protein (Walker, 1965; Wahn and Ganster, 1982; Taitz and Armitage, 1984; Park, 1994; Haenlein, 2004). (Soothill, 1987) reported that children who were reactive or allergic to bovine milk but not to goat milk also reacted to bovine milk cheese but not to goat milk cheese. In another study, administration and feeding of goat milk also improved gastrointestinal allergy in certain infants (Rosenblum and Rosenblum, 1952). In an extensive feeding trial, (Walker, 1965) showed that only 1 in 100 infants who were allergic to cow milk did not thrive well on goat milk of 1,682 patients with allergic migraine, 1,460 were due to food, 98 due to inhalants, 98 due to endogenous (bacterial) substances, and 25 due to drugs (including tobacco). Among the 1,460 patients with food allergy, 92% were due to cow milk or dairy products; 35% wheat; 25% fish; 18% egg; 10% tomato; and 9% chocolate. Some patients were allergic to more than one food. In another experiment, approximately 40% of allergic patients sensitive to cow milk proteins were able to tolerate goat milk proteins (Brenneman, 1978). These patients may be sensitive to cow lactalbumin, which is species specific. Other milk proteins, such as β-lactoglobulin, are also shown to be responsible for cow milk allergy (Zeman, 1982; Heyman and Desjeux, 1992). Many scientists have recommended evaporated goat milk or goat milk powder for infant formula (McLaughlan, *et*

al., 1981; Juntunen and Ali Yrkko, 1983; Taitz and Armitage, 1984; Coveney and Darnton-Hill, 1985), because heat applied to manufacturing processes reduces allergic reactions (Perlman, 1977). Heat denaturation alters basic protein structure by decreasing its allergenicity (Macy *et al.*, 1953) and high heat treatment removes sensitizing capacity of milk (McLaughlan, *et al*., 1981). Because goat milk has relatively low αs_1-casein content, it is logical that children with high sensitivity to αs_1-casein of cow milk should tolerate goat milk quite well (Chandan *et al*., 1992).

Perlman (1977) observed that lactalbumin from goat milk showed a different skin reaction in comparison with its bovine milk counterpart and that there was a variation of skin test reaction to allergenic fractions of bovine milk and goat milk. The data indicate that some proteins of bovine milk gave higher incidences of positive skin test reactions than goat milk. (Podleski, 1992) reported that inconsistency in cross-allergenicity among milk of different species may be qualitative and quantitative. A few reports using gel electrophoretic precipitation analysis also showed that there was a certain immunological cross-reactivity between cow and goat milk proteins (Saperstein, 1960; Parkash and Jenness, 1968; McClenathan and Walker, 1982).

There is a wide variety of genetic polymorphisms of the different caseins and whey proteins (Grosclaude, 1995), which adds to the complexity of the cow milk allergy (CMA) situation and the difficulty of determining which protein is mainly responsible for an allergic reaction. However, Bevilacqua *et al*.,(2000) have shown that this genetic protein diversity may actually help identify which protein is the allergen, if genetic polymorphisms of milk proteins are specifically used for clinical tests. Compared to cow milk, goat milk contains much less or nondetectable amounts of αs_1-casein (Jenness, 1980; Chandan *et al*., 1992; Remeuf, 1993). In French clinical studies over 20 years with cow milk allergy patients, (Sabbah *et al*., 1997) concluded that substitution with goat milk was followed by "undeniable" improvements. In other French extensive clinical studies with CMA children, the treatment with goat milk produced positive results in 93% of the children and was recommended as a valuable aid in child nutrition because goat milk had less allergenicity and better digestibility compared to cow milk (Grzesiak, 199)

Nutritional and therapeutic properties of goat milk

Goat milk also exhibits significant nutritional and therapeutic functions in abnormal or disease conditions of human nutrition and health, due mainly to some of its biologically active compounds. Reports have shown that therapeutic and nutritional advantages of goat milk over cow milk come not from its protein or mineral differences, but from the lipids, more specifically the fatty acids within the lipids (Babayan, 1981; Park, 1994; Park and Haenlein, 2006). Goat milk fat contains significantly greater contents of short and medium chain length fatty acids (C_4:0–C_{12}:0) than the cow counterpart (Babayan, 1981; Chandan *et al.*, 1992; Park, 1994; Park and Haenlein, 2006).

Goat milk has smaller fat globule size compared to cow and other species' milk. Comparative average diameters of fat globule for goat, cow, buffalo and sheep milk were reported as 3.49, 4.55, 5.92, and 3.30 μm, respectively (Fahmi *et al*., 1956). The smaller fat globule size of goat milk would have better digestibility compared to cow milk counterparts (Chandan *et al*., 1992). The short and medium chain fatty acids in goat milk have been shown to possess several bioactive functionalities in digestion and metabolism of lipids as well as treatment of lipid malabsorption syndromes in a variety of patients (Park, 1994; Park and Haenlein, 2006). Goat milk proteins are also believed to be more readily digestible, and their amino acids absorbed more efficiently than those of cow milk. Caprine milk forms a softer, more friable curd when acidified, which may be related to lower contents of αs_1-casein in the milk (Jenness, 1980). It may be logical that smaller, more friable curds of goat milk would be attacked more rapidly by stomach proteases, giving better digestibility (Jenness, 1980).

Caprine milk also has better buffering capacity than bovine milk, which is good for the treatment of ulcers (Devendra and Burns, 1970). In a comparative study of buffering capacity (BC) using Caprine milk, bovine milk, and commercial bovine milk infant formulae, (Park, 1991) reported that Nubian goat milk had the highest BC among all tested milk and that the major buffering entities of milk were influenced by species and breeds within species. Due to the compositional differences, milk of Nubian goat breed showed a higher BC compared with the milk of Alpine breed, Holstein cows, and Jersey cows. Nubian goat milk had highest levels of total N, protein, non protein N (NPN) and phosphate (P_2O_5) among the four breeds of goat and cow milk. Regardless of breed, goat milk contained significantly higher non protein N than cow milk (Park, 1991). The BC is influenced by proteins, primarily casein and phosphate components in milk (Watson, 1931). Soy based infant formulae contained less total N and NPN compared with natural goat and cow milk, and BC of the formulae were also lower than those of natural milk. The higher BC of Nubian goat milk compared to cow milk would be important in human nutrition. (Mack, 1953) conducted a nutrition trial involving 38 children (20 girls and 18 boys) aged 6 to 13 years by feeding one - half of them 0.946 liter of goat milk and the other half 0.946 liter of cow milk daily for 5 months. The study revealed that children in the goat milk group surpassed those on cow milk in weight gain, statue, skeletal mineralization, bone density, blood plasma vitamin A, calcium, thiamine, riboflavin, niacin and hemoglobin concentrations.

Statistical differences were minimal for blood hemoglobin and various other biochemical and structural measurements between the two groups. In another study of a feeding trial of anemic rats, goat milk also showed a greater iron bioavailability than cow milk (Park *et al*., 1986), indicating that the iron compounds in goat milk, such as lactoferrin, may be more bioactive than those in cow milk. In recent Spanish studies, (Barrionuevo *et al*., 2002) removed 50% of distal small intestine of rats by resection, simulating the pathological condition of mal absorption syndrome, and found that the feeding of goat milk instead of cow milk as part of the diet resulted in significantly higher digestibility and absorption of iron and copper, thereby preventing anemia. In a separate trial, they also found that the utilization of fat and weight gain was improved with goat milk in the diet, compared to cow milk, and levels of cholesterol were reduced, while triglyceride, HDL, GOT, and GPT values remained normal (Alferez *et al.,* 2001). It was concluded that the consumption of goat milk reduces total cholesterol levels and the LDL fraction because of the higher presence of medium-chain triglycerides (MCT) (36% in goat milk vs. 21% in cow milk), which decreases the synthesis of endogenous cholesterol.

In an Algerian study, (Hachelaf *et al.,* 1993) also found that 64 infants with mal absorption syndromes, who had the substitution of cow milk with goat milk, resulted in significantly higher rates of intestinal fat absorption. Thus goat milk was again recommended as a "useful alternative to cow milk for rehabilitating undernourished children." Considering the results of these nutritional studies, Caprine milk apparently has certain growth factors and bioactive components, which may not be equally available in bovine milk.

CONCLUSIONS

Caprine milk recommended as a "useful alternative to cow milk" because Caprine milk apparently has certain growth factors and bioactive components, which may not be equally available in bovine milk. Therefore the consumption of Caprine milk and its derived dairy product reduced allergic problem and increased disease resistance mechanism compared to bovine milk consumed by human being.

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