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Physico-Chemical Properties of Goat Milk

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Annotation: Goat milk has been traditionally valued for its high nutritional and biological properties, offering significant health benefits. Despite these advantages, it remains underutilized compared to cow milk due to limited processing technologies and low awareness. Existing studies insufficiently address the comparative physico-chemical properties of goat milk relative to human and cow milk, particularly in the context of nutritional optimization. This study aims to conduct a comparative analysis of the physico-chemical composition of goat, cow, and human milk to highlight goat milk's unique qualities and its potential in human nutrition. The results show that goat milk surpasses cow milk in fat, protein, and mineral content, with smaller fat globules aiding digestibility. It also contains more vitamins A, C, and niacin, and demonstrates bactericidal properties, remaining fresh longer at room temperature. The study reveals that goat milk forms finer curd particles in the stomach and is naturally homogenized, making it particularly beneficial for infants, the ill, and during recovery periods. These findings underscore goat milk's potential as a superior alternative in infant and clinical nutrition and call for further development of technologies for its wider application in the food industry.

Keywords: Goat milk, Milk composition, Nutritional value, Biological value, Dairy products, Comparative analysis, Physico-

chemical properties, Human milk, Cow milk, Unique characteristics, Spring season milk, Literature review, Milk research, Goat milk benefits, Functional food.

Introduction

Throughout the evolutionary development of humans, plant and animal-based foods were consumed in their natural form. Such a diet provided the body with essential nutrients and energy necessary for life. The rapid advancement of scientific and technological progress has led to significant changes in the qualitative and quantitative composition of nutrition. Various technological processing and storage methods have deprived humans of many important metabolic regulators. The proper selection of healthy food should be based on the physiological needs of the human body for nutrients and energy, as well as on the recommended daily intake levels. The development of research in the field of food hygiene and the creation of new food technologies help expand the variety of food products and encourage the search for new sources of raw materials. The production of healthy food products is becoming increasingly important to prevent common nutrition-related diseases [1].

An imbalanced diet disrupts the balance of nutrients such as energy, protein, fat, carbohydrates, vitamins, and minerals. As a result, this leads to metabolic disorders and the emergence of various diseases [such as intestinal dysbiosis, diabetes mellitus, goiter, vitamin deficiency, etc.]. Changes in the normal microbiocenosis of the gastrointestinal tract impair the assimilation of food components and disrupt metabolic processes in the body [2]. An example of preparing a balanced diet and producing specialized food products is the creation of combined food products from raw milk [3]. One of the most distinctive and important qualities of milk as a food product is its high biological value and digestibility due to the presence of complete proteins, milk fats, minerals, trace elements, and vitamins. The digestibility of milk and dairy products reaches up to 95–98%. In recent years, research has significantly expanded knowledge about the fundamental and unique compositional characteristics of goat milk. The high biological and nutritional value of goat milk makes it suitable for use in the diets of weakened and frequently ill children, for digestive system disorders, and during the rehabilitation period after surgeries and bone fractures [4].

Methodology

The methodology of this study is based on a comprehensive literature review and comparative analysis of the physico-chemical properties of milk from different mammalian sources, particularly goat, cow, and human milk. The research involved the collection and synthesis of existing scientific data from peer-reviewed articles, textbooks, and nutritional studies that focused on the composition and health benefits of goat milk. Quantitative data on parameters such as fat content, protein concentration, mineral and vitamin levels, lactose amount, density, and digestibility were extracted from various sources and systematically compared. Tables summarizing key compositional differences were created to support the analytical approach. The analysis took into account seasonal influences, especially the characteristics of milk obtained in spring, and variations due to lactation periods. Additionally, this methodology included evaluation of biological effects such as digestibility, curd formation in gastric conditions, and bactericidal properties by referencing clinical and animal-based studies cited in prior research. Emphasis was placed on identifying the nutritional superiority and functional advantages of goat milk in contexts such as infant feeding, recovery nutrition, and food allergy alternatives. The reliability of findings was ensured through cross-verification of data across multiple scientific publications. While the study did not involve experimental lab-based procedures, it adhered to scientific rigor by basing interpretations on statistically supported, previously validated findings.

The method of comparative analysis employed allowed the researchers to clearly differentiate the strengths and limitations of goat milk, thereby providing a scientifically grounded foundation for drawing conclusions and recommending further investigation into goat milk's applications.

Results and Discussion

The unique composition of goat milk is associated with diverse feeding practices and is not restricted by specific diets and schedules as is the case with cows. Scientists have determined that goats are among the healthiest and cleanest animals, and they are less prone to serious diseases such as tuberculosis and brucellosis, which commonly affect cows . Despite its high nutritional value, goat milk and its derivatives remain relatively unknown due to the lack of stable technologies and limited raw material resources [5]. In modern literature, the possibility of replacing cow milk with goat milk in the diet of children with cow milk protein allergies has long been discussed. The main reason goat milk is considered more suitable for infant nutrition is its similarity to human milk. The lactoferrin protein in human milk protects the newborn from infections and is a key source of iron [6].

Animal studies have shown that goat milk accelerates the regeneration of damaged intestinal mucosa. This effect on the affected mucosa may be associated with the high content of triglycerides and growth factors in goat milk, as well as its oligosaccharides [7]. In terms of chemical composition and properties, goat milk is similar to cow milk, differing mainly in its higher content of proteins, fats, and minerals. Due to its lower carotene content, its color is also lighter. The fat globules in goat milk are smaller in size compared to those in cow milk, which helps them to be better absorbed by the human body. Goat milk is rich in vitamins C, A, and niacin. It is used in infant nutrition and, when mixed with sheep milk, is used to produce white cheese and certain other cheeses [8] (Table 1).

Table 1. Milk composition of different mammals

№	Animals	density, g/sm	Dry metter, %	fat, %	Total protein, %	casein, %	Alb+glob., %	Sugar [glucose], %	ash, %
1	Cow	1,030	12,4	3,1	3,3	2,7	0,6	4,7	0,6
2	Goat	1,031	13,1	3,7	4,1	3,1	0,7	4,5	0,8
3	Dromedary camel	1,031	13,6	4,5	3,5	2,5	1,0	4,9	0,7
4	Breast milk	1,031	12,1	3,6	1,8	1,2	0,6	6,5	0,2

Goat milk contains more vitamin A compared to cow milk. Additionally, goats convert all carotene into vitamin A, producing white milk. The content of B vitamins in both goat and cow milk is a result of synthesis in their abdominal cavity and is somewhat independent of diet. Overall, the B group vitamins, especially riboflavin, are present in higher amounts, but cow milk contains more vitamin B6 and B12. Goat milk also has a higher content of niacin. The levels of vitamins C and D are approximately the same. Goat milk contains more calcium, potassium, magnesium, phosphorus, chlorine, and manganese compared to cow milk, but less sodium, iron, sulfur, zinc, and molybdenum.

A comparative analysis of human, goat, and cow milk ratios was presented in the scientific research [9].

The protein content in cow and goat milk is similar, ranging from 3.65% to 3.55%, while the amount in human milk is lower. The lactose levels in cow and goat milk also differ slightly, with the level in human milk reaching 4.71%.

The density of milk depends on its composition: the content of dry matter, which includes fats,

proteins, lactose, and mineral salts, varies from 1027 to 1034 kg/m³. With an increase in the dry matter content [excluding fat], the density of milk increases, as the density of proteins is 1280 kg/m³, mineral salts are 2160 kg/m³, and milk sugar is 1550 kg/m³.

The mineral content in cow and goat milk is approximately 0.81–0.82%, while in human milk, it is 0.70%. Various factors affect the composition of milk: the lactation period, age, nutrition, and care, as well as individual characteristics (Table 2).

Table 2. Comparative Ratio of Human, Goat, and Cow Milk, %

№	Milk	Contain, %						
		fat	SOMO	protein	density	water	sugar	Mineral substances
1	Breast milk	3,42	8,08	3,13	29,5	0,54	4,71	0,70
2	Goat	5,2	10,67	3,66	28,5	0,6	5,59	0,82
3	Cow	5,05	10,53	3,65	33,5	0,7	5,37	0,81

In cows, the average lactation period lasts 300 days, while in goats, it lasts from 150 to 210 days. During lactation, the composition of milk changes according to the months of lactation. The amounts of fat and protein decrease during the second to fourth or sixth months of lactation, then increase, while the lactose content remains relatively stable [10].

Conclusion

The study highlights the distinctive physico-chemical properties of goat milk, revealing its superior digestibility, higher content of essential nutrients such as fats, proteins, vitamins A and C, and beneficial minerals like calcium and magnesium when compared to cow and human milk. These findings emphasize the potential of goat milk as a functional dietary component, particularly suited for vulnerable populations such as infants, individuals with digestive disorders, and those recovering from illness. The naturally homogenized structure of goat milk and its bactericidal properties further enhance its value in both clinical and everyday nutritional applications. The implications of this research suggest a need for increased awareness and development of stable technologies to support wider industrial utilization of goat milk products. Future research should explore optimized processing methods, allergenic potential, and the development of specialized dietary formulations that fully leverage the unique benefits of goat milk.

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