



Advancing Nutrition through Value-Added Goat Milk Products

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Abstract

Goat rearing plays a pivotal role in enhancing rural livelihoods, nutritional security, and income generation, particularly in developing countries like India. Goat milk is highly valued for its superior digestibility, rich nutrient composition, and therapeutic properties. This article reviews the composition, functional attributes, and post-harvest processing technologies associated with goat milk, along with emerging value-added products. Goat milk contains bioactive components such as short-chain fatty acids, oligosaccharides, and bioactive peptides that contribute to improved gut health, immunity, and metabolic functions. Its lower allergenicity and higher mineral bioavailability make it an ideal alternative to cow milk, especially for sensitive populations. Advances in processing techniques, including fermentation, ultrafiltration, and spray drying, have enabled the development of diversified products such as cheese, yoghurt, butter, ice cream, and milk powder. Additionally, integration into traditional dairy products enhances its acceptance in local markets. The growing demand for functional foods and nutraceuticals has further amplified the importance of goat milk-based products. This review highlights the scope of post-harvest processing and value addition in improving product quality, shelf life, and economic returns, thereby contributing to sustainable livestock development and rural entrepreneurship.

Key words: Goat Milk, Value Addition, Functional Food

Introduction: The Role of Goat Rearing in Rural Livelihoods

Goat rearing is a cornerstone of rural economies across India and many developing nations. With their hardiness, low maintenance, and adaptability to varied environments, goats are particularly suited for smallholder and marginal farming systems. They provide a continuous supply of milk and meat, serving both nutritional and income-generating purposes. The livestock sector in developing countries is one of the fastest-growing agricultural subsectors, accounting for 33% of agricultural GDP. This growth is fueled by increasing urbanization, population growth, and rising incomes (BAHS, 2023).

India, with the world's largest goat population, leads in global milk production, generating 230.58 million tonnes in 2022-23. Goat milk contributes 3.3% of this total. On the meat front, India ranks fifth globally, with 14.47% of total meat production coming from goat meat (chevon), the most widely consumed red meat in the country (BAHS, 2023). These figures reflect

not only the dietary relevance of goats but also their economic and developmental significance.

Goat Milk: Composition, Nutritional Value, and Health Benefits

While goat milk appears similar to cow milk, its nutritional properties are distinct. It contains higher levels of short-chain fatty acids caproic (C6), caprylic (C8), and capric (C10) which contribute to its characteristic taste and medicinal properties. These fatty acids have demonstrated potential in inhibiting the growth of cancer cells and supporting gene regulation for apoptosis. Unlike cow milk, goat milk has a slightly alkaline nature, enhancing its digestibility and soothing the digestive tract.

Goat milk also boasts a higher concentration of oligosaccharides, especially sialyloligosaccharides, which support the development of healthy gut microbiota. Its oligosaccharide and nucleotide profiles closely resemble those of human breast milk, making it ideal for infant nutrition, particularly in cases of cow milk intolerance. Lower levels of α s1-casein

reduce allergenic potential, and the milk has shown benefits in conditions like malabsorption syndrome, intestinal inflammation, and childhood diarrhoea, especially when enriched with human lysozyme (hLZ). Furthermore, goat milk is rich in calcium, magnesium, selenium, and bioactive peptides with immunomodulatory and antioxidant effects, supporting bone health, metabolism, and disease prevention.

Table 1. Nutritional and Functional Components of Goat Milk

| Component | Major Constituents | Functional Significance |
|---------------------|--|--|
| Fat | Caproic, caprylic, capric acids | Easy digestion, antimicrobial activity |
| Protein | Casein (low α s1-casein), whey proteins | Hypoallergenic, bioactive peptides |
| Carbohydrates | Lactose, oligosaccharides | Prebiotic effect, gut health |
| Minerals | Ca, P, Mg, K | Bone health, metabolic regulation |
| Vitamins | A, B2, B12, D | Immunity, metabolism, vision |
| Bioactive compounds | Nucleotides, peptides | Immune enhancement, anti-inflammatory |

Value Addition: Transforming Goat Milk into High-Value Products

The true economic and nutritional potential of goat milk lies in its value-added processing, which creates a wide variety of consumer products as shown in Fig. 1 for both local and export markets.

1. Liquid Milk Products

Goat milk, with its naturally homogenized fat and higher digestibility, offers unique advantages over cow milk. Its lower α s1-casein content and smaller fat globules make it suitable for people with mild lactose intolerance or protein allergies. Technologies such as enzymatic treatment with β -galactosidase to produce galacto-oligosaccharides (GOS) enhance its prebiotic value and sensory acceptability (Zhu *et al.*, 2018). Such modifications not only improve taste and stability under acidic and heat conditions but also position goat milk as a functional health beverage, especially among health-conscious consumers.

2. Butter

Value addition in goat milk butter production focuses on overcoming challenges such as its naturally soft texture and relatively low yield. This is achieved by optimizing fermentation and churning techniques. Cultured goat cream butter, prepared by inoculating cream with

mesophilic lactic acid bacteria, significantly enhances sensory attributes such as flavour, aroma, and spreadability, while also extending shelf life. Key processing parameters like fermentation temperature, duration, and culture concentration play a vital role in improving butter consistency and acceptability. Due to its lower cholesterol content and smooth, easily spreadable texture, goat milk butter appeals particularly to health-conscious and gourmet consumers. When stored at an ideal temperature of around 15°C, it exhibits optimal firmness and spreadability, making it a premium alternative to traditional cow milk butter (Rodríguez *et al.*, 2003).

3. Cheese

Goat milk cheese, including varieties such as soft, semi-hard, and traditional white slice cheeses, benefits from its rich content of short-chain fatty acids, contributing to its sharp flavour. Despite a lower cheese yield due to low α s1-casein, ultrafiltration (UF) techniques significantly enhance recovery of protein and fat, improving texture, nutritional value, and economic returns (Mehaia, 2002). Goat milk cheese is especially suitable for consumers seeking digestive ease, and innovations like regional specialties (e.g., Croatian white slice cheese) expand market potential.

4. Ice Cream and Frozen Desserts

Goat milk serves as an excellent base for value-added frozen desserts, including probiotic ice creams and fruit-flavoured frozen yogurts. Inclusion of ingredients like carob powder, chocolate, or exotic fruits enhances flavour while masking goaty notes. Technologies developed for manufacturing probiotic-rich ice cream preserve the viability of beneficial microbes over extended frozen storage. Low-fat variants using skimmed goat milk also maintain acceptable sensory and textural attributes, catering to health-conscious consumers seeking indulgence with added nutritional benefits (Ranadheera *et al.*, 2013).

5. Yoghurt and Fermented Milk Products

Yoghurt made from goat milk is gaining popularity due to its superior digestibility, immune-modulatory benefits, and suitability for individuals allergic to cow milk. Fortification with whey proteins, casein, or folate-producing cultures improves texture, nutritional profile, and functional value. Traditional products like *Kishk* and *Labneh* further diversify goat milk's applications, while experimental blends with cow milk create balanced sensory profiles. Functional fermentation using probiotic strains

(e.g., *Lactobacillus fermentum*, *L. rhamnosus*) enhances antioxidant, anti-inflammatory, and anti-atherogenic properties, promoting gut and immune health (Harmayani, 2015).

6. Milk Powder

Spray drying of goat milk adds value by improving shelf stability, transportability, and convenience. Optimized processing parameters such as solid content and inlet temperature ensure retention of nutrients and minimize goaty flavour, especially when mixed fruit flavour is added. Goat milk powder contains essential amino acids, nucleotides, and a non-protein nitrogen profile closer to human milk, making it ideal for infant formulas and medical nutrition. Its production supports year-round supply chains and opens up export opportunities in the nutraceutical and pediatric nutrition markets (Prosser, 2021).

7. Traditional Indian Dairy Products

Goat milk can be effectively used in the preparation of traditional Indian dairy products such as ghee, paneer, chhana, shrikhand, and chakka. These products benefit from the unique composition of goat milk, offering softer textures and distinct flavours. Paneer and chhana made from combinations of goat and buffalo milk improve mouthfeel and reduce the goaty aroma. Process optimization in coagulant concentration and temperature yields higher quality products (Pal *et al.*, 2017). Such value addition not only caters to ethnic and regional preferences but also boosts rural entrepreneurship and local food processing industries.

8. Non-Food Applications: Cosmetics

In the cosmetic industry, goat milk's caprylic and capric acids improve skin permeability, making it a preferred base for lotions, shampoos, soaps, and facial creams. Its natural emollient properties help moisturize and soothe sensitive skin, contributing to its growing demand in organic and therapeutic skincare products.



Fig. 1 Various commercially available value-added milk products from goat milk

Conclusion

Goat milk holds significant promise not only as a nutritional powerhouse but also as a driver of rural development and entrepreneurship. Its therapeutic potential, coupled with superior digestibility and nutritional profile, makes it suitable for a wide range of consumers from infants and elderly to people with allergies or gut disorders. Through scientific processing and targeted value addition, goat milk can be transformed into diverse, profitable, and health-oriented products. By investing in this underutilized resource, stakeholders can support rural livelihoods, enhance food and nutrition security, and tap into emerging health-conscious markets both domestically and globally.

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