



## An Insight into Health Benefits of Non Bovine Milk

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Non-bovine milk (from goats, sheep, camels, donkeys, and mares) is increasingly recognized as a functional food with unique nutritional and therapeutic properties, offering alternatives for those with lactose intolerance or cow milk allergies. Recent studies highlight their antioxidant, anti-inflammatory, and disease-preventive potential. Based on the 2019 Livestock Census, India reported populations of 148.88 million goats, 0.25 million camels, 74.3 million sheep, 0.06 million yaks, and 0.39 million mithuns (GoI, 2020). These non-bovine species are predominantly maintained by marginal farmers, often under challenging and ecologically degraded conditions, as a critical source of livelihood. Cattle and buffaloes constitute the predominant milch species in India, collectively accounting for approximately 95% of national milk output. In contrast, several non-bovine species—including goats, sheep, camels, mares, and reindeer—produce milk with distinctive nutritional and therapeutic properties beneficial to human health, yet these species remain comparatively underexplored (Park and Haenlein, 2006). Non-bovine milk is characterized by a diverse array of bioactive constituents, including functionally active lipids, lactose, immunoglobulins, immune proteins, peptides, nucleotides, oligosaccharides, and metabolites. Furthermore, its unique chemical composition and microbial ecology present opportunities for exploitation in human health promotion. For instance, camel milk has been recognized as a medicinal food with potential therapeutic applications, while donkey milk, owing to its hypoallergenic properties, is particularly suitable for infant nutrition. The present study examines the nutritional and therapeutic attributes of non-bovine milk, with the objective of formulating strategies to optimize its potential for enhancing human nutrition and expanding its applications within the pharmaceutical sector.

**Table 1: Health benefits of non bovine milk**

Milk Type	Nutritional Highlights	Health Benefits	Cultural/Regional Use
Goat Milk	Smaller fat globules, higher vitamin A, easier digestibility	Lower allergenicity, supports gut health	Widely consumed in Mediterranean & South Asia
Sheep Milk	Rich in protein, calcium, and zinc	Stronger bone health, immune support	Basis for cheeses like Roquefort, Pecorino
Camel Milk	High in vitamin C, lactoferrin, immunoglobulins	Anti-inflammatory, supports diabetes management	Traditional in Middle East & Africa
Donkey Milk	Rich in lysozyme, omega-3 fatty acids	Antioxidant, skin health, immune modulation	Used in cosmetics and infant nutrition
Mare Milk	High lactose, low fat	Probiotic potential, supports gut microbiota	Consumed in Central Asia (fermented as <i>koumiss</i> )

## Scientific Insights

Milk-derived bioactive peptides, released either during gastrointestinal digestion or fermentation by lactic acid bacteria, are increasingly recognized as valuable components in functional foods. Peptides from cow, buffalo, goat, sheep, and camel milk exhibit diverse biological activities, including antimicrobial, immunomodulatory, antioxidant, antihypertensive, antithrombotic, opioid-like, hypocholesterolemic, and appetite-regulating effects. Their functional roles during digestion warrant further evaluation for incorporation into food formulations. Translating the potent properties of peptides from non-bovine milk into nutritional and clinical applications represents a promising area for future research.

- **Bioactive compounds:** Lactoferrin, lysozyme, immunoglobulins, peptides, vitamins C & E, and polyunsaturated fatty acids contribute to antioxidant and anti-inflammatory effects. Antioxidant activity: Camel and donkey milk contain lactoferrin, lysozyme, vitamins C and E, and polyunsaturated fatty acids that activate antioxidant pathways (Nrf2-ARE). Anti-inflammatory effects: Non-bovine milks suppress NF- $\kappa$ B signaling and modulation of cytokines ( $\downarrow$  IL-6, IL-1 $\beta$ , TNF- $\alpha$ ;  $\uparrow$  IL-10) reduce inflammation. Donkey milk is naturally hypoallergenic, suitable for infants with cow's milk protein allergy (Li et al., 2025). Sheep and goat milk proteins enhance immunoglobulin activity and gut microbiome balance.
- **Digestibility:** Goat and donkey milk are easier to digest due to smaller fat globules and lower allergenicity compared to cow milk. Smaller globules create a finer emulsion, which is broken down more efficiently by digestive enzymes. This leads to faster gastric emptying and reduced digestive discomfort. Thus, people with sensitive stomachs or mild lactose intolerance often tolerate goat and sheep milk better. Goat and sheep milk contain less  $\alpha$ 1-casein compared to cow milk which form a softer, more easily broken-down curd than cow milk.
- **Allergenicity:** Goat and Sheep Milk Contain lower levels of  $\alpha$ 1-casein, a protein strongly linked to allergic reactions in cow milk. Form softer curds in the stomach, making them easier to digest. Camel Milk lacks  $\beta$ -lactoglobulin, a major allergen in cow milk shows hypoallergenic properties and often tolerated by individuals with cow milk protein allergy (CMPA). Donkey Milk closely resembles human breast milk in protein composition, naturally hypoallergenic and suitable for infants with cow milk allergy. It is rich in lysozyme and immunoglobulins as well as contain lower levels of  **$\alpha$ 1-casein** which support immune protection. **Camel Milk** Lacks  $\beta$ -lactoglobulin, which is a major allergen in cow milk. This is often tolerated by individuals with cow milk protein allergy (CMPA) and shows hypoallergenic properties. **Donkey Milk** Closely resembles **human breast milk** in protein composition. It is naturally hypoallergenic, rich in lysozyme and immunoglobulins, which support immune protection and suitable for infants with cow milk allergy (Kanetkar et al., 2025).

## Value-added products from non-bovine milk

The global use of goat and sheep milk in dairy processing is steadily increasing, particularly for cheese and yoghurt production. Goat milk is valued for its digestibility and unique composition, which influences cheese yield, curd texture, and yoghurt quality. A variety of goat milk products—including powders, condensed milk, cultured butter, whey protein concentrates, and ice cream—are commercially available, alongside cosmetic applications such as soaps, creams, and shampoos, owing to the permeability-enhancing effects of its medium-chain fatty acids (Pal et al., 2024). Sheep milk, with its higher solids content (15–16%), provides superior raw material for cheese, yoghurt, and ice cream. Its elevated protein, fat, calcium, and casein levels contribute to desirable texture and flavor, reducing the need for stabilizers. Sheep milk cheeses form an important part of traditional diets worldwide, including Feta, Roquefort, Manchego, Pecorino Romano, Ricotta, and Bryndza varieties, while yoghurt from sheep milk is also widely consumed in Mediterranean regions.

Camel milk is recognized as a nutrient-rich functional food, notable for its high mineral content and elevated levels of vitamins, particularly vitamin B3 (supporting digestive, skin, and neural health) and vitamin C, which occurs at concentrations several times higher than in cow milk and contributes to its anti-infective properties. Beyond direct consumption, camel milk is processed into fermented and pasteurized products, butter, cheese, and powdered forms, while its traditional by-products (urine and dung) have been utilized in folk medicine. Modern innovations have expanded its applications to ice cream, flavored milk, paneer, whey beverages, and traditional sweets, underscoring its potential as a natural therapeutic resource with relevance for both nutrition and disease management. Yak milk is utilized for producing a range of value-added dairy products, including paneer, low-fat paneer, yoghurt, cream, butter, ghee, whey beverages, and traditional hard cheeses such as chhurpi and churkam. Similarly, mithun meat has been processed into various commercial products, alongside paneer, yoghurt, and dried milk powders. Donkey milk, due to its close resemblance to human milk and natural hypoallergenic properties, can be preserved through freezing, drying, or spray-drying for later reconstitution. It is incorporated into confectionery items such as chocolates, cookies, and candies, and is also widely applied in cosmetic and therapeutic formulations, including soaps, creams, lotions, and antibacterial products (Bekhit et al., 2022).

### Risks & Considerations

- **Availability:** Non-bovine milk is less widely produced, making it more expensive and region-specific. Goat and sheep milk is widely available in Mediterranean countries and parts of India. Camel milk is common in Rajasthan, Gujarat, Middle East, and North Africa. Whereas, donkey milk is a niche product, limited to small farms in Europe and select Indian regions. Yak milk is mainly found in Himalayan areas (India, Nepal, Tibet).
- **Safety:** Raw camel or donkey milk may carry pathogens; pasteurization is essential. There is higher risk of microbial contamination if milk is consumed raw; pathogens like *Salmonella*, *Listeria*, and *E. coli* can be present. Adulteration related to mixing with bovine milk to reduce costs is a growing concern; requires biomarker-based diagnostics for detection. While donkey milk is hypoallergenic, goat and sheep milk may still trigger reactions in sensitive individuals. Non-bovine milk often has higher fat and protein content, making it prone to spoilage without proper refrigeration.
- **Regulatory gaps:** Limited standardized guidelines for processing and quality control compared to cow/buffalo milk.
- **Regulation:** Limited global standards for processing and marketing compared to cow milk. Unlike cow/buffalo milk, there are no universally accepted protocols for pasteurization, fermentation, or preservation of camel, goat, sheep, donkey, or yak milk. This leads to inconsistent safety and quality across producers. Testing frameworks (fat %, protein %, microbial load) are tailored to bovine milk. Non-bovine milk has different compositions (e.g., higher vitamin C in camel milk, hypoallergenic proteins in donkey milk), but these are not adequately monitored. Absence of labeling standards and Packaging often lacks clear nutritional information or species-specific certification, making it difficult for consumers to trust authenticity. As, export markets demand strict compliance with Codex Alimentarius or EU standards, but India and many other countries lack equivalent frameworks and limited international harmonization for non-bovine milk
- **Economic Risks:** Non-bovine species (e.g., camels, donkeys, yaks) often require specialized care, feed, and environments, which increase costs compared to cattle or buffalo. Small herds limit output, making it harder to compete with large commercial dairies that benefit from bulk production and reduced per-unit costs. Seasonal and regional constraints makes availability of milk from species like yaks or camels to specific climates and seasons, leading to inconsistent supply. Demand for niche products (camel milk, donkey milk) is growing but remains unstable, exposing farmers to price fluctuations making market volatile. Moreover, there is lack of cold chains, processing

facilities, and distribution networks makes it difficult to deliver products safely and efficiently to wider markets.

### Future Prospects

- Growing demand for **functional foods** and **alternative dairy** is driving research into processing methods that enhance safety and bioactivity.
- Non-bovine milk could play a role in **personalized nutrition**, especially for populations with dairy sensitivities.
- Value-added products derived from non-bovine milk are gaining significant traction in both domestic and international markets, with potential to be positioned as future functional superfoods.
- Priority should be given to the comprehensive characterization of bioactive molecules and in vitro-generated peptides to enhance their commercial utilization.
- Non-bovine milk, owing to its nutritional superiority, holds considerable economic value; identification of unique metabolites as biomarkers is essential for quality monitoring.
- Development of diagnostic tools based on differentiating biomarkers is required to detect adulteration with bovine milk.
- Promotion of entrepreneurship and small-scale dairies focused on non-bovine milk, supported by digital marketing platforms, can strengthen the sector.
- Financial incentives and policy support are critical for establishing a robust value chain for non-bovine milk and its products.

### References

1. Bekhit, A.E.D.A., Ahmed, I.A.M. and Al-Juhaimi, F.Y. (2022). Non-bovine milk: Sources and future prospects. *Foods*, 11(13):1967.
2. GoI-Government of India. (2020). Annual Report 2019-20, Ministry of Fisheries, Animal Husbandry and Dairying, New Delhi, India.
3. Kanetkar, P., Panta, R., Bakshi, S., Ola, M., Singh, G. and Paswan, V.K. (2025). Research Trends in Non-Bovine Milk: Key Areas, Advancement, and Challenges. *Trends in Animal-Based Foods*, 1-25.
4. Li, Y., Ma, Q., Li, M., Liu, W., Liu, Y., Wang, M., Wang, C., Khan, M.Z. (2025). Non-Bovine Milk as Functional Foods with Focus on Their Antioxidant and Anti-Inflammatory Bioactivities. *Antioxidants* (Basel), 27;14(7):801.
5. Pal, M., Rebuma, T., Pinto, S., Molnar, J. and Bhardwaj, N. (2024). Emerging Role of Non-Bovine Milk from Human Health Perspective. *J. Nutrition and Food Processing*, 7:13.
6. Park, Y.W. and Haenlein, G.F. (2006). Overview of milk of non-bovine mammals. In: Handbook of Milk of Non-bovine Mammals (Park, Y.W. and G.F.W, Haenlein, eds). *Blackwell Publishing*, Ames, Iowa, USA.