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Non-Bovine Milk Sources: A Future-Ready Alternative

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Abstract

As global demand shifts toward sustainable and functional foods, non-bovine milk varieties such as goat, sheep, camel, donkey, and yak milk are emerging as vital alternatives to traditional cow's milk. These milks offer superior physicochemical properties, including high digestibility, hypoallergenic proteins, and potent bioactive compounds that support the metabolic and immune health of consumers. Furthermore, non-bovine livestock production is more environmentally resilient, requiring fewer resources and offering lower carbon footprints. This article highlights how advancements in food technology and increasing health consciousness are positioning non-bovine dairy products as a cornerstone of a diversified, eco-friendly, and nutrient-dense global food system.

Keywords: *Non-bovine milk, Functional foods, Bioactive compounds, Sustainability, Hypoallergenic dairy, Food innovation*

Introduction:

Milk has been consumed for centuries and is a good source of nutrients that promote growth and health. Although cow milk is the most consumed milk in the global market, other types of milk from goats, sheep, camels, and yaks are gaining popularity. These alternatives are often more sustainable for individuals with dietary restrictions or allergies than traditional dairy products. Therefore, the rise in popularity of these milk varieties is due to the increasing concern for environmental sustainability and changing dietary trends (Alichanidis *et al*., 2016). Non-bovine milk is nutritionally dense and contains bioactive compounds that meet various health needs. Food processing technologies have also been improved to make them more appealing to health-conscious consumers and those seeking eco-friendly options (Ramsing *et al*., 2023).

Physicochemical Characteristics and Health Benefits:

- ✓ **Goat Milk:** Goat's milk is widely perceived as more digestible and less reactive than cow's milk and contains 3.0-3.6 % protein and 3.5-6.0 % fat, has long and medium fatty acid chains (MCFAs) that are more easily metabolised for energy. Vitamins A, B_2, B_6, and D, and minerals such as calcium and magnesium are also present to maintain bone health (Kompan and Komprej, 2012). It is therapeutically proven to support intestinal health and can benefit persons with inflammation (Haenlein, 2004).
- ✓ **Sheep Milk:** Sheep milk is a source of nourishment that contains 5.4-6.0% protein, 6.0-9.0% fat, vitamins A and E, and minerals, especially zinc and phosphorus. With its creamy texture, sheep milk is ideal for developing nutrient-rich dairy products. Body bone health improvement, immunity building, and anti-inflammatory effects (Park *et al.,* 2007).
- ✓ **Donkey milk:** Similar to human breast milk, donkey milk is highly nutritious, has no allergens, and is incredibly well digested. It contains 1.5-1.8% protein and a very high vitamin content, which helps support immune function and skin health. Its antimicrobial properties are attributed to bioactive compounds, such as lactoferrin, making it suitable for treating inflammatory conditions and supporting cardiovascular health (Li *et al.,* 2020).
- ✓ **Camel Milk:** Hailed as “white gold,” camel milk contains vitamins C and B and minerals such as potassium and iron. It is also low in lactose, making it ideal for those who cannot digest lactose. Therefore, the bioactive proteins in camel milk improve insulin sensitivity, offering therapeutic potential for diabetes management. Furthermore, it aids in gut and mental health (Gizachew *et al.*, 2014).
- ✓ **Yak Milk:** It is reasonably plentiful in energy, and this milk has a higher percentage of fat than cow milk. In addition, omega fats, along with vitamins A, D, and E, strengthen bones and are excellent for cardiovascular health. It helps combat oxidative stress and metabolism by containing antioxidants and conjugated linoleic acid (CLA) (Guo *et al.,* 2014).
- ✓ **Mithun Milk:** In grazing conditions, gamma-linolenic acid, one of the rare fatty acids present in sheep milk, could be converted into conjugated linoleic acid. It was concluded that the CLA content of mithun milk is higher than that of cow and buffalo milk. The folks do not distinguish between these sentences. Good for health. Observe the definitions to obtain information on underlying or enabling words or kernel transformation at the background level (Zhang *et al.,* 2014).

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Health Consciousness and Dietary Needs:

The growing awareness of lactose intolerance and milk allergies has significantly influenced consumer preferences. Non-bovine milk options provide digestible and allergen-friendly alternatives that meet dietary needs. For instance, the lower alpha-S1-casein content of goat milk reduces its allergenic potential, whereas camel and donkey milk cater to lactose-intolerant individuals with lower lactose levels. Non-bovine milk is also rich in fatty acids, mainly omega-3, antioxidants, and bioactive peptides, which facilitate cardiovascular health benefits, boost immunity, and reduce inflammation, thus making it a good prospect for health-oriented consumers looking for functional or nutrient-rich drinks (Lee-Chang *et al*., 2016).

Sustainability and Environmental Benefits:

Non-bovine milk production is more environmentally sustainable than traditional dairy farming methods. For example, animals such as goats and camels require less land and water than cows. Additionally, they produce fewer greenhouse gas emissions, which is a key factor in the global push for eco-friendly food choices to address the resource-intensive nature of cow farming (Ramsing *et al.* 2023). Furthermore, goats, sheep, and yaks can withstand harsh environmental conditions, thereby contributing to the development of rural economies, elevating the status of women, and enhancing sustainable agricultural production (Castro *et al*., 2023).

Table-1: Physicochemical Characteristics and Health Benefits of Non-Bovine Milk

Types of Milk	Protein (%)	Fat (%)	Lactose (%)	Key Nutrients	Therapeutic Benefits
Goat Milk	3.0 - 3.6	3.5 - 6.0	4.1 - 4.7	Calcium, Magnesium	Digestive aid and anti-inflammatory
Sheep Milk	5.4 - 6.0	6.0 - 9.0	4.8 - 5.2	Vitamins A & E	Skin health and anti-inflammatory
Donkey Milk	1.5 - 1.8	1.1 - 1.8	Low	Vitamins A, B_1, B_2	Hypoallergenic and immune support
Camel Milk	Varies	Varies	Low	Vitamins C & B	Insulin sensitivity and gut health
Mithun Milk	High	High	Varies	Calcium	Immune support and metabolic health
Yak Milk	High	High	Varies	Omega-3 fatty acids	Cardiovascular health

(Literature compiled from various sources)

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Figure-1: A detailed systematic diagram for non-bovine milk sources: a future-ready alternative

Future prospects of non-bovine milk:

With increased consumer interest in sustainable, ethical, and healthy products, the future looks bright and promising. Innovations in food processing technologies, especially precision fermentation, have improved the flavour, texture, and nutrient attributes of non-bovine milk, allowing it to compete seriously with conventional cow's milk. New products, such as fortified non-bovine milk and plant-based mixtures, indicate market diversification trends. They align with dietary preferences while being environmentally friendly and ethical. Veganism and plant-based diets have been trending; the global market share of non-bovine milk is expected to grow (Lee-Chang *et al*., 2016).

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Conclusion:

Non-bovine milk varieties, ranging from goat and sheep to the more specialised camel and yak milk, represent a transformative shift in the global dairy landscape, offering a potent combination of therapeutic benefits and ecological resilience. These alternatives effectively address the limitations of traditional cow's milk by providing hypoallergenic proteins, superior digestibility, and unique bioactive compounds that support the cardiovascular, metabolic, and immune health of consumers. Beyond individual nutrition, the transition toward non-bovine dairy aligns with urgent global sustainability goals, as these hardy species typically require fewer resources and produce a lower environmental footprint. As food processing innovations continue to refine the sensory profiles of these milks and consumer demand for ethical, functional foods intensifies, non-bovine milk is poised to evolve from a niche market into a cornerstone of a more diversified, health-conscious, and sustainable global food system.

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