



COMPARATIVE ANALYSIS OF COW MILK AND CAMEL MILK: NUTRITIONAL COMPOSITION AND HEALTH EFFECTS

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ABSTRACT

Cow milk and camel milk differ significantly in composition, digestibility, and bioactive properties. This review synthesizes studies published comparing their nutritional profile and health implications. Cow milk is higher in casein, calcium, and fat, making it suitable for growth and bone health. Camel milk contains less β -lactoglobulin and α s1-casein, higher vitamin C, iron, and insulin-like proteins. Clinical and animal studies show camel milk improves glycemic control in Type 1 and Type 2 diabetes, reduces insulin requirements, and is better tolerated in cow milk allergy. Cow milk remains superior for calcium and protein density. The choice between the two depends on nutritional needs and health status.

KEYWORDS: Camel Milk, Cow Milk, Nutritional Composition, Diabetes, Allergy, Iron Deficiency

INTRODUCTION

Milk is a key source of protein, calcium, and energy worldwide. Cow milk dominates global consumption, while camel milk is a staple in arid regions of Africa, the Middle East, and Rajasthan, India. Camel milk gained scientific attention after studies reported its therapeutic potential in diabetes, autism, and food allergy. The main differences lie in protein structure and bioactive components. Camel milk lacks β -lactoglobulin and α s1-casein, the primary allergens in cow milk, and contains insulin-like proteins and higher levels of vitamin C and iron. This paper compares cow milk and camel milk based on studies published.

NUTRITIONAL COMPOSITION

Camel milk and cow milk share a similar water base but differ significantly in their nutrient delivery. Camel milk stands out for its exceptional health profile, offering up to forty times more Vitamin C and three times more iron than cow milk. Additionally, it provides a lighter option with lower overall fat and slightly reduced lactose levels. While cow milk remains a stronger source of calcium and stable casein proteins, camel milk serves as a highly nutritious alternative.

Table 1: Average Composition per 100 mL

Component	Camel milk	Cow milk
Water	87–89%	87–88%
Fat	2.5–3.5%	3.5–4.5%
Protein	3.0–3.5%	3.2–3.4%
Casein	1.63–2.76%	2.5–2.7%
Whey Protein	0.6–0.7%	0.6–0.7%
Lactose	4.2–4.8%	4.8–5.0%
Calcium	114–116 mg	120–130 mg
Iron	0.15–0.20 mg	0.05 mg
Vitamin C	24–40 mg/L	1–2 mg/L

Sources: Konuspayeva et al.(2009); El-Agamy (2007); Al haj & Al

Kanhal (2010).

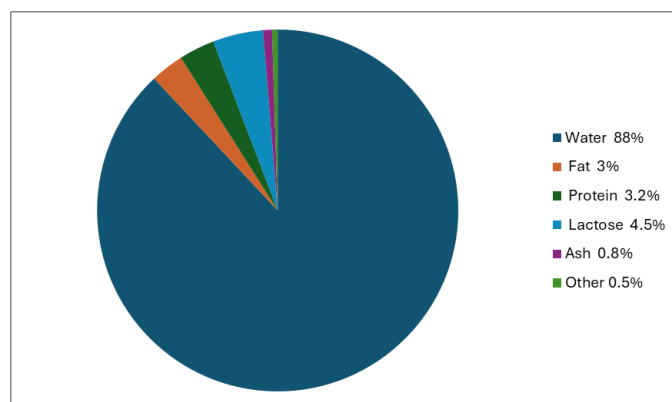


Figure 1: Camel Milk Composition

BIOACTIVE COMPONENTS AND FUNCTIONAL PROPERTIES

Camel milk exhibits unique therapeutic properties due to its distinct bioactive protein profile. It is less allergenic and easier to digest than cow milk because it completely lacks β -lactoglobulin and contains minimal α s1-casein. Additionally, it offers powerful immune and antimicrobial defense through significantly higher concentrations of immunoglobulins, lactoferrin, and lysozyme. Most notably, camel milk contains insulin-like proteins that assist in glycemic control, making it a valuable dietary option for diabetes management.

Table 2: Bioactive Components and Functional Differences

Component / Property	Camel Milk	Cow Milk	Health Implication
β -Lactoglobulin	Absent	Present	Camel milk less allergenic
α s1-Casein	Very low	High	Better tolerance in allergy

Immunoglobulins IgG	2.2 mg/mL	0.6 mg/mL	Enhanced immunity
Lactoferrin	0.2–0.4 mg/mL	0.1 mg/mL	Antimicrobial, anti-inflammatory
Lysozyme	0.05–0.1 mg/mL	0.001 mg/mL	Antibacterial activity
Insulin-like Proteins	Present	Absent	Glycemic control in diabetes
pH	6.5–6.7	6.6–6.8	Similar acidity
Clotting Time	Slower	Faster	Affects digestibility

Sources: El-Agamy (2007); Konuspayeva (2009); Shabo (2005).

DIGESTIBILITY AND ALLERGENICITY

Lactose Tolerance and Digestive Comfort

Camel milk presents a highly viable option for individuals struggling with dairy sensitivities due to its unique sugar profile. It contains slightly lower lactose levels than standard bovine milk, which significantly reduces the gastrointestinal burden and improves overall tolerance in mildly lactose-intolerant individuals.

Hypoallergenic Properties and Pediatric Tolerance

The molecular structure of camel milk makes it remarkably hypoallergenic compared to traditional dairy. Clinical studies confirm that children with severe allergies to cow milk can safely tolerate camel milk because it completely lacks β -lactoglobulin and contains virtually no α s1-casein the two primary proteins responsible for triggering dairy allergies. Notably, research by Shabo *et al.* (2005) reported an impressive 92% tolerance rate when testing camel milk in highly allergic pediatric patients.

Casein Micelle Structure and Efficient Digestion

The structural biology of camel milk proteins further enhances its superior digestibility in the human gut. Its casein micelles are significantly larger than those in cow milk, measuring between 260–300 nm in diameter. This distinct structural arrangement leads to the formation of a much softer, more fragmented curd in the stomach, which prevents heavy bloating and enables faster gastric emptying.

THERAPEUTIC APPLICATIONS AND FUNCTIONAL HEALTH BENEFITS

Diabetes Management and Glycemic Control

Clinical research underscores the potent therapeutic role of camel milk in managing endocrine disorders. Longitudinal randomized controlled trials conducted in Rajasthan demonstrated that daily supplementation with 500 mL of raw camel milk over a three-month period significantly optimized glycemic control in patients diagnosed with Type 1 diabetes (Agrawal *et al.*, 2005, 2007). This dietary intervention achieved a substantial 30% to 35% reduction in exogenous insulin dosage requirements while concurrently inducing sharp, statistically significant drops in both fasting and postprandial blood glucose levels.

Iron Bioavailability and Anemia Prevention

The unique biochemical matrix of camel milk serves as an excellent dietary solution for micro-nutrient deficiencies, particularly iron deficiency anemia. Structural analyses reveal

that the iron content in camel milk is uniquely bound to lower molecular weight casein fractions, which greatly improves its stability and transit across the intestinal barrier (Konuspayeva *et al.*, 2009). Furthermore, this absorption pathways is heavily accelerated by its high concentrations of native Vitamin C which measures three to five times higher than that of conventional bovine milk drastically enhancing non-heme iron bioavailability and cellular uptake.

Immunological Defense and Antimicrobial Activity

Beyond basic nutrition, camel milk operates as a powerful immunomodulatory agent due to its rich concentration of protective bioactive proteins. It delivers markedly higher physiological levels of lactoferrin, lysozyme, lactoperoxidase, and heavy-chain immunoglobulins compared to standard dairy, providing robust antimicrobial and anti-inflammatory coverage. Peer-reviewed studies confirmed that these combined therapeutic proteins exert strong inhibitory effects against dangerous pathogenic bacteria, demonstrating targeted antibacterial activity against *Escherichia coli*, *Staphylococcus aureus*, and *Helicobacter pylori*.

LIMITATIONS AND SAFETY

Raw camel milk can carry zoonotic pathogens like *Brucella* and *Mycobacterium bovis*. Pasteurization is recommended. Cow milk has standardized processing and fortification, making it safer for mass consumption. Cow milk is also cheaper and more widely available. Camel milk production is limited and costlier.

CONCLUSION

Evidence shows that cow milk is nutritionally dense in calcium and protein, supporting growth and bone health. Camel milk offers unique advantages in diabetes management, cow milk allergy, and iron deficiency due to its bioactive proteins, low allergenicity, and high vitamin C and iron content.

For general nutrition, cow milk remains the standard. For therapeutic use in diabetes, allergy, and anemia, camel milk presents a viable alternative.

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