White Gold: The Therapeutic Revolution of Camel Milk

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ABSTRACT

Camel milk, traditionally referred to as the "White Gold" of the desert, has transitioned from a nomadic survival staple to a globally recognized functional superfood with profound therapeutic potential. Its unique chemical profile is characterized by low cholesterol, low sugar, and a critical lack of beta-lactoglobulin, the primary allergen in bovine milk, making it a safe alternative for individuals with dairy sensitivities. This "natural medicine" is distinguished by a high concentration of insulin-like proteins that remain bioactive through gastric passage, offering a potent aid for glycemic control in Type 1 diabetic patients. Furthermore, its dense profile of protective proteins, including lactoferrin, immunoglobulins, and lysozyme, provides robust antimicrobial and antiviral defense. Clinical research also highlights its role in mitigating oxidative stress through high levels of Vitamin C and glutathione, which has been linked to behavioral improvements in children with Autism Spectrum Disorder. From an industrial perspective, the rising demand for these health benefits is driving a market projected to reach $21.2 billion by 2036. The sector is rapidly diversifying into high-value, climate-resilient products such as freeze-dried powders, specialized infant formulas, and anti-aging cosmeceuticals, positioning camel milk as a cornerstone of future functional nutrition.

INTRODUCTION

For centuries, nomadic populations in arid regions have relied on camel milk as a primary source of sustenance. Often referred to as the **"White Gold"** of the desert, its significance transcends mere nutrition. Historical accounts suggest that desert dwellers could survive for over a month consuming nothing but camel milk, largely due to its striking similarity to human breast milk and its dense profile of protective proteins. In the modern era, camel milk is transitioning from a localized survival food to a globally recognized functional superfood and a **"boon"** to the dairy industry (Alhassani *et al.,* 2024).

Its unique chemical composition is characterized by low cholesterol, low sugar, and a lack of beta-lactoglobulin, which is the primary protein responsible for cow milk allergies in humans. Instead, it is rich in protective proteins such as lactoferrin, lactoperoxidase, immunoglobulins, and lysozyme, providing a robust natural defense against bacterial and viral infections. (Akanksha *et al.,* 2026). One of its most notable medicinal properties is its high concentration of insulin-like proteins - approximately 52 µU/ml - which are encapsulated in a way that protects them from stomach acid, offering a potent natural aid for glycemic control in Type 1 diabetic patients (Alhassani *et al.,* 2024; Agrawal *et al.,* 2011).

Physical and Chemical Profile

Camel milk is distinct from the milk of other ruminants in its physical appearance and chemical behavior.

Physical Characteristics

- **Color and Appearance**: It is generally opaque white in color
- **Flavor Profile**: It possesses a faint sweetish odor and a sharp, sometimes salty taste, which can vary based on the type of forage consumed by the camel.
- **Density and pH**: The density ranges from **1.026 to 1.035**, with a pH between **6.2 and 6.5**, which is notably lower than that of bovine milk.
- **Stability**: Camel milk remains stable for longer periods at room temperature and does not coagulate over seven days even at 30°C (Abdelazez *et al*., 2024).

Proximate Composition

According to FAO standards, the typical composition of dromedary camel milk includes:

- **Water**: 87%
- **Protein**: 3.1%
- **Fat**: 3.5%
- **Lactose**: 4.4%
- **Ash**: 0.79%
- **Total Solids**: 11.9%

Comparative Nutritional Analysis

(Gahroui *et al*., 2022)

Proximate	Camel %	Cow %	Buffalo %	Human %
Water	86–88	85–87	82–84	88–89
Fat	2.9–5.4	3.7–4.4	7.0–11.5	3.3–4.7
Lactose	3.3–4.4	4.8–4.9	4.5–5.0	6.8–7.0
Ash	0.6–0.9	0.7–0.8	0.8–0.9	0.2–0.3

When compared to other species, camel milk displays unique advantages, particularly for human infants and those with specific dietary restrictions.

Functional Fats

The fat in camel milk is naturally homogenized, with a small average globule

size of **2.99 µm**, making it significantly easier for the human digestive system to process (Khaliq *et al.,* 2024).

- **Fatty Acids**: It is rich in polyunsaturated fatty acids, including high concentrations of essential **linoleic acid**.
- **Cholesterol**: It contains lower cholesterol (**26.63 mg/100g**) than cattle milk (**35.40 mg/100g**).

Proteins and Protective Agents

The protein content (3% to 3.90%) is composed of caseins and whey proteins (Harizi *et al.,* 2024)

- **Absence of Allergens**: Most importantly, camel milk **lacks β-lactoglobulin**, the primary protein responsible for cow milk allergies in humans.
- **Immune Proteins**: It contains high levels of lysozyme, lactoferrin, lactoperoxidase, immunoglobulins, and peptidoglycan recognition protein (PRP).

Minerals and Vitamins

- **Vitamin C**: Camel milk contains **3 times more Vitamin C** than cow milk, contributing to powerful antioxidant activity.
- **Iron**: The iron content is **10 times higher** than that of bovine milk, making it an excellent tool for preventing anemia.
- **B-Vitamins**: It contains higher concentrations of Vitamin B3 (niacin) and Vitamin B1 (thiamine) compared to bovine sources (Almasri *et al*., 2024).

Therapeutic and Clinical Applications

- **Diabetes Management** - Camel milk contains high concentrations of insulin (**52 µU/ml**) compared to bovine milk (**23 µU/ml**) (Kaskous, 2016; Mirmiran *et al*., 2017)
- **Autism and Brain Health** - Autism is linked to oxidative stress and weak immunity. Camel milk increases antioxidant enzymes (superoxide dismutase and glutathione), leading to improved behavior, language, and coordination in children (Al-Ayadhi *et al*., 2015)

Gastrointestinal Health

- **Gastrointestinal Health** - The immunoglobulins in camel milk help combat autoimmune conditions like Crohn's disease. Camel milk is also rich in anti-rotavirus antibodies, lysozyme, and lactoferrin, it effectively treats infant diarrhea (He *et al*., 2022)
- **Cosmeceuticals and Anti-Aging** - High amounts of Vitamins C, E, and A act as strong antioxidants to prevent cellular damage. α-Hydroxyl Acids in milk help eliminate wrinkles, age spots, and dryness (Ahmad *et al*., 2017)

Current Market Scenario and Practical Facts

Industry Status (India)

- **Global Rank**: India ranks 7th globally in camel milk production, yielding approximately 23.08 thousand tons annually (ICAR-NRCC, 2024).
- **FSSAI Standards**: Standards for camel milk specify a minimum of 3% milk fat and 6.5% SNF (FSSAI, 2017).
- **Commercialization**: **Amul** (GCMMF) markets camel milk as pasteurized bottled milk, chocolates, ice cream, and powder (eDairy News, 2026)

Farming Facts

- **Yield**: The average daily milk yield is 3–10 liters.
- **Lactation**: The lactation period is 14–16 months, with a total yield of 2000–2700 kg per lactation.
- **Shelf Life**: Unprocessed milk lasts 5 days at 7°C, while pasteurized milk lasts 22 days at the same temperature. Frozen milk can be stored for 1 year (Kumar *et al*., 2022)

CONCLUSION

In conclusion, camel milk represents a unique fusion of ancient tradition and modern therapeutic science, establishing itself as a vital "natural medicine" for the 21st century. Its status as a nutritional powerhouse is anchored in a chemical composition that is significantly lower in cholesterol and sugar than bovine milk, yet vastly superior in essential nutrients like Vitamin C and iron.

The clinical benefits of camel milk extend to neurological and gastrointestinal health, where its rich profile of antioxidants and protective proteins like lactoferrin and immunoglobulins helps mitigate oxidative stress in children with autism and combats autoimmune conditions such as Crohn's disease. From a commercial perspective, the rise of camel milk processing into high-value products - ranging from freeze-dried powders with a one-year shelf life to premium anti-aging cosmeceuticals - is providing a significant economic boon to the dairy industry. As major brands like Amul continue to standardize and popularize these products, camel milk is positioned to remain a high-value, climate-resilient cornerstone of global functional nutrition.

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