

# Milk of Camel: Science Edification Urgencies

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**Abstract:** Camel milk is rich in numerous bioactive substances that function beyond their nutritive value. Camel milk is more similar to goat milk and contains less short-chain fatty acids than cow, sheep and buffalo milks, and about 3 times greater vitamin-C than cow milk. One kg of camel milk meets 100% of daily human requirements for calcium and phosphorus, 57.6% for potassium, 40% for iron, copper, zinc and magnesium, and 24% for sodium. Camel milk helps treat liver problems, lowers bilirubin output, lightens vitamin inadequacy and nutrient deficiency, and boosts immunity. Camel milk reduces allergies caused by cow dairy products. Camel milk has low milk fat made mainly from polyunsaturated fatty acids. It lacks  $\beta$ -lactoglobulin and is rich in immunoglobulins, compatible with human milk. Persistent systematic education of camel milk science will be an obligation for health implications to be optimally perceived by worldwide human populations.

**Keywords:** Camel, Education, Health, Immunity, Milk.

## INTRODUCTION

Asia, Europe and North America produce most of the world milk products (Figure 1) [1]. The most of milk produced is from cattle except for Asia where cattle and buffalo are the key milk producers (Figure 1). The science of non-cow milks has, however, not been broadly, scientifically, and systematically appreciated by the public. Public education on health implications of

## MILK AS A FUNCTIONAL FOOD AND MEDICINE

Milk secretion results from pregastric fermentation of plant cells that generate volatile fatty acids (VFA) and microbial mass [2, 3]. Milk is considered the most natural functional food. Such a global nutritional fame is because milk is produced from most abundant, least digestible matters in the nature (e.g. cellulose), and also because it encompasses numerous bioactives that

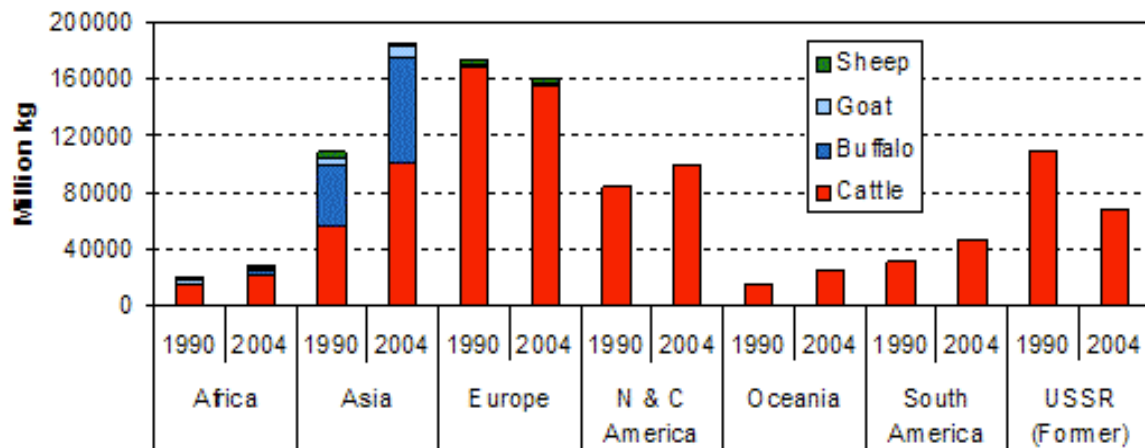


Figure 1: Total world ruminant milk production.

camel milk as a replacement for cow milk is especially inevitable. The objective of this article is to delineate exclusive nutritional and technological properties of camel milk in providing healthy foods for humans in the new era, and to help optimize milk science education worldwide with an emphasis on camel dairy foods.

function beyond their nutritive value. No food can replace milk for neonatal development of brain, nervous, immune, and skeletal systems, which is an evolutionary testimony for its irreplaceable roles in creation of upcoming higher quality generations [3]. Lactating women on milk secret breast milk enriched with  $\beta$ -lactoglobulin and ovalbumin [4]. Livestock milk may be enriched with vitamin-E for greater nutritional value [5]. Milk from immunized ruminants has reduced hypercholesterolemia [6]. Conjugated linoleic acid

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(CLA) of mainly CLA cis9, trans11 (75-90%) and CLA trans10, cis12 have implications as anti-carcinogenic, anti-atherogenic, anti-inflammatory, and anti-lipogenic agents [7, 8]. As such, ruminant research has attempted to manipulate nutritional programs to enrich milk with CLA [7]. Milk immunoglobulins act against *Enterotoxigenic Escherichia coli* [9]. Dairy consumption has also reduced metabolic syndromes [10]. Whey proteins are insulinotropic and medium chain fatty acids improve insulin action and fat metabolism. Medium and short chain fatty acids in milk specifically butyric acid, publically considered likely unhealthy, can improve intestinal nutrient assimilation and insulin sensitivity [11, 12].

Given the versatile raising environment, evolution, genetics, and feeding management, milk composition differs vastly among livestock (Table 1). Protein and calcium supplies from animal foods including dairy products vary considerably among countries. Average intake in many regions is well below minimum daily requirements of about 70 g protein and 800 mg calcium [13]. Camel milk is produced very economically by animals living in the toughest environments. Camel milk is three times richer in vitamin C than cow milk. In some countries including Iran, Russia, Kazakhstan and India, camel milk is prescribed for early and effective recovery from a variety of disorders. Its vitamin C, iron, unsaturated fatty acids and B-family vitamins boost immunity. Nonetheless, the public awareness of non-cow dairy foods nutritional and health perspectives is highly insufficient. The limited global insight reflects the

much less available research data and more importantly the less emphasized education, compared to cow dairy foods.

## NOVEL CAMEL MILK SCIENCE

Camel milk has on average 11.7% total solids, 3.0% protein, 3.6% fat, 0.8% ash, 4.4% lactose, and a pH of 6.5. The levels of Na, K, Zn, Fe, Cu, Mn, niacin and vitamin-C are greater and that of thiamin, riboflavin, folacin, vitamin B12, pantothenic acid, vitamin-A, lysine and tryptophan are relatively lower compared to cow milk. Milk fat has a molar % of 26.7 palmitic acid, 25.5 oleic acid, 11.4 myristic acid, and 11.0 palmitoleic acid. Camel milk is more similar to goat milk and contains less short-chain FA than cow, sheep and buffalo milks. *In vitro* protein digestibility and protein efficiency ratio values were 81.4% and 2.69, respectively, based on 90.0% and 2.50 for ANRC-Casein. Camel milk contains substantially less vitamins-A (0.10 vs. 0.27 mg/L) and B2 (0.57 vs. 1.56 mg/L), similar vitamin-E content (0.56 vs. 0.60 mg/L), and about 3 times greater vitamin-C (37.4 vs. 11.0 mg/L) than cow milk, respectively [14].

Camel is known as the gold goal pseudo-ruminant of the 21st century in arid regions and drylands. In Kazakhstan, 37% of the total milk is produced by camel, with sheep, yak and cows producing 30%, 23% and 10%, respectively. Camel milk production varies from 3.5 up to 40 L per day under intensive management. Lactation lasts between 9-18 months, with peak yield occurring during the first 2-3 months

**Table 1: Average Milk Composition per 1 kg of Milk**

Component	Cow	Buffalo	Breast	Camel
Fat, g	40	70	40	45
Protein, g	34	40	19	35
Lactose, g	48	51	65	44
Minerals, g	7	8	2	7
Solids-non-fat, g	90	98	73	86
Total solids, g	133	167	121	128
Cholesterol, mg	140	90	200	370
Calcium, g	1.20	1.95	3.20	1.43
Phosphorus, g	0.93	1.74	1.4	1.16
Saturated FA, g	24	42	18	24
Monounsaturated FA, g	11	17	16	14
Polyunsaturated FA, g	1	2	5	5

FA = fatty acids.

postpartum. In another study, the range of major contents of camel milk were: fat 2.9-5.5%, protein 2.5-4.5%, lactose 2.9-5.8%, ash 0.35-0.95%, water 86.3-88.5% and SNF 8.9-14.3%, with a mean specific gravity of 1.03 [15].

The camel milk is receiving more recognition as a global product in optimizing human health. The FAO predicts the camel dairy products will appear on European supermarket shelves. However, logistic challenges in manufacturing and processing must be overcome. Despite the increasing demands from Sahara to Mongolia, the annual 5.4 million tones camel dairy products are greatly inadequate. Sector and local investments must escalate to meet demands and create profitable markets both in the Middle East and the Western world. There are about 300 million potential customers in the Middle East and millions more in Africa, Europe and the Americas for camel dairy products. Although somewhat saltier than cow milk, camel milk represents a cost-effective husbandry under toughest conditions. Camel milk is 3 times richer in vitamin-C than cow milk. In many regions of Iran, Russia, Kazakhstan and India, camel milk has traditionally been prescribed as a food treatment for multiple diseases recovery [16-18]. Oral camel milk administration has proved protective against cadmium induced toxicity in rats [19]. Camel milk is also known for its rich iron, unsaturated fatty acids and B-vitamins.

A main challenge in camel milk processing is its incompatibility with the Ultra High Temperature (UHT) exposure, which is to preserve milk. Also, most camel producers have a nomad nature. An additional challenge is that camels are reputedly stubborn animals. Unlike cows and other docile ruminants storing all their milk in udders, camels store their milk further up the body. Besides all, camel milk production might be considered an inferior-technology business, such that a scanty 5 L daily secretion is regarded a decent yield. Even under extensive production, improved feeding, husbandry and veterinary services should enable daily yields of up to 40 L. There seems to be at least 17 million camels (*Camelus dromedarius*) in the world including 12 million in Africa and 5 million in Asia [1]. Milk production varies between 1,500 and 15,000 kg during a lactation of 9 and 18 months [20].

Camel milk has 21 different amino acids [20]. One kg of camel milk supplies 100% of daily human requirements for calcium and phosphorus, 57.6% for potassium, 40% for iron, copper, zinc and magnesium, and 24% for sodium [21]. Saturated acids comprise

about 61% of milk FA, including palmitin (27%), stearin (14.7%), myristic acid (12.4%), with kapron and capric acid being only 0.8% [22]. Thus, camel milk fat is made of 39% unsaturated FA. Camel milk can help treat some liver problems, lower bilirubin output, lighten vitamin inadequacy and nutrient deficiency, and augment immunity [21]. Fermented camel milk contains some minor amount of alcohol, and 12.4% of dry matter including 4.8% fat, 3.6% protein, 0.12 mg/kg carotene and 56 mg/kg vitamin-C. One kg of fermented milk has 766 kcal energy. From each 3 L of fermented milk, 1 kg of curd is produced, almost half of the curd yield in sheep, goat and cow milk. Processing 100 kg of camel milk in temperatures between 50-55°C can yield 9-10 kg of sour cream with 66% of fat. Processing the same amount of camel milk in temperatures between 45-55°C can generate 12-14 kg of sour cream with 35-40% of fat [23]. One kg of curds is derived from 6 L of camel milk, one kg of dried curd is produced from 9.1 L of milk, one kg of melted butter with 98% of fat is made from 15 L of milk with 5.66% of fat, one kg of sour cream with 76.8% of fat is made from 13.5 L of milk with 5.66% of fat. Fermented camel milk is made of pure starter culture. It must be stirred 5000-6000 times by electrical beaters every 3 h. Fermentation starts at temperatures of 20-25°C for the first 24 h. After that it should be cooled down to 18-20°C. Fermentation will be complete after 6 h. The fermented milk can be kept for 60 days in dark bottle at a temperature of 40-50°C and becomes ready for consumption. Carbonated fermented milk can be preserved up to 90 days.

A major use of camel milk is in allergy caused by various foods, especially ruminant-made foods of mainly cow milk and milk products. Such allergies may cause anaphylactic reactions. These include 1) immediate reaction within 45 min of drinking cow milk that leads to urticaria, angioedema and likely true anaphylactic reactions; 2) medium reactions occurring 45 min to 20 h that manifests with pallor, vomiting and diarrhea; and 3) long-term reactions happening > 20 h with mixed reactions in the skin and respiratory and gastrointestinal tracts. Camel is a non-ruminant, despite ruminating, or so called Tylopode. Camel milk is exclusive by its rather low milk fat of about 2% that is made mainly from polyunsaturated FA. These FA tend to be fully homogenized and form smooth white milk. In addition, camel milk proteins are the most determining constituents in preventing/curing food-born allergies. This is because camel milk lacks  $\beta$ -lactoglobulin [24] and possesses a different  $\beta$ -casein (Beg, 1986) than cow milk. These proteins make cow milk allergenic.

Moreover, camel milk contains many immunoglobulins, being compatible with human counterparts. Camel milk is also rich in vitamin-C, calcium and iron, thus boosting immune function. Camel milk was recently shown to cure allergies in children of 8-mon to 10-yr old [17].

In several regions of Iran, Pakistan and India, camel milk has long been used therapeutically against dropsy, Jaundice, spleen and liver complexities, tuberculosis, asthma, anemia, and piles [25]. Camel milk is healthier when it is drunk as a cool drink [26]. The milk also apparently has slimming properties [27]. The belief by the Bedouin of the Sinai Peninsula exists that any internal disease can be cured by drinking camel milk through driving from the body all the bacteria. Such milk properties must additionally be attributed to what camel eats. Milk from camel consuming straw might not exhibit the favorable health effects. By the rule of thumb considerations, generally camel milk nutritional value would be considered the lowest following milk from ewe, goat and cow. However, 4–5 kg of camel milk and milk products are sufficient to meet energy, lipids, proteins and calcium requirements of a man.

Following immediate use, the left-over camel milk is curdled and soured. The casein prepared from this milk product is called 'industrial casein' [28]. It is not very firm for human intake, and is rather used for glue and gums making. The industrial casein from cow milk is however rich in proteins. The whey proteins of camel milk are richer in nitrogen compared to cow milk [28]. The high proteins and amino acid proportions of camel milk casein make camel milk an appropriate food supplement for humans. The unfavorable odor and taste, however, could affect its popularity. Thus, it is recommended to purify the camel industrial casein to maintain its competitive status in the human health markets.

## IMPLICATIONS

Camel milk has traditionally been used to treat liver problems, lower bilirubin output, reduce vitamin inadequacy and nutrient deficiency, and boost immunity. Camel milk reduces food allergies caused by cow milk and milk products. Camel milk has low milk fat content with increased PUFA proportions. Camel milk lacks  $\beta$ -lactoglobulin and is rich in immunoglobulins, thus being compatible with human milk. More research is needed to further characterize biophysical and biochemical properties of camel milk as a functional substitute for cow milk and other animal products.

Future research must be programmed within public education contexts. Persistent education will be a commitment for such milk natural health implications to be optimally perceived by science and public communities worldwide.

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