

Nutritional Profile, Chemical Composition, and Health Benefits of Yak Milk

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Abstract

Since antiquity, milk has been consumed by people of all religions throughout the world. Milk is an important source of essential nutrients that are required to human beings for maintaining good health. Yak milk's distinctive composition and high nutritional value make it potentially beneficial for a wide range of medical conditions. It is an excellent source of vitamins, minerals, vital fatty acids, and protein, all of which improve general health and well-being. Scientific research has demonstrated that yak milk includes peptides that have antihypertensive qualities, suggesting possible treatment advantages for hypertension. The antioxidant qualities of yak milk have also been demonstrated to help shield against oxidative stress and the health issues it may bring about. Additionally, the fat derived from it has higher concentrations of heart-healthy fats, like omega-3 fatty acids and conjugated linoleic acid, which have been connected to many health benefits, such as a decrease in inflammation, support for heart health, and improvement of cognitive function. Therefore, the objective of this review is to highlight the nutritional profile, chemical composition, and health benefits of yak milk.

Keywords

Chemical composition, Health benefit, Nutritional profile, Yak milk

1. Introduction

Milk, chiefly produced from cows, is used by both sexes, all age groups, and in all seasons globally, but other animals, such as buffalo, goat, camel, donkey, yak, bison, sheep, Mithun, reindeer, etc., are also kept for milk production in several regions of the world [1-3]. The long-haired yak (*Bos grunniens*) is indigenous to South Central Asia's Himalayan area, which includes portions of Tibet, Nepal, Bhutan, and India. Along with domestic cattle, bison, and buffalo, it is a member of the *Bovidae* family. Additionally, yaks have thick fur that protects them from the cold and low oxygen levels, making them well-suited to life at high elevations. Since they are herbivores, their main food sources are lichens, grasses, and herbs. Yaks are utilized for more than just their meat; their high-protein, high-fat milk, and wool, used to construct textiles and apparel, are also produced from them [4].

Yaks play a significant role in the Himalayan region's economy and culture. They are utilized in traditional ceremonies and festivals, as well as for transportation and as pack animals [5]. The most common milk-producing genotype found in the Himalayan region's high altitudes and snow-bound regions is yak. Yaks are typically found at elevations between 2500 and 6000 meters above mean sea level (MSL), where they can survive in extremely cold temperatures (-40°C) and high pressure (550 hPa) [6].

All of the essential elements that mammals, including humans, need can be found in milk [7]. Every lactation, yaks produce between 150 and 500 kg of milk, depending on the breed, age, parity, and physical condition of the animals, as well as pasture growth, quality, growing regions, timing, and other environmental factors. In the regions where yaks graze

on alpine meadows and mountain pastures, yak milk and its products make up the majority of the Tibetan herders' daily food, especially for the frail, sick, aged, and young. Yak milk and its byproducts, such as butter and cheese, are essential sources of vitamins and a key source of nourishment for Tibetan herders because they face a dearth of fruit and vegetables and restricted food resources [8]. According to [9], yak milk's high fat, protein, lactose, and mineral content during the major breastfeeding phase earns it the moniker "natural concentrated milk."

Yak milk and its products may offer functional benefits such as supporting immune function, reducing inflammation, and improving heart health [10]. Yak milk and its derivatives exhibit a wide range of bioactive properties. These include antioxidant effects, which help combat oxidative stress and prevent cellular damage, and anticancer agents, which display properties that may inhibit the growth and spread of cancer cells [11]. Furthermore, they have demonstrated antimicrobial activity, which can contribute to the prevention and treatment of microbial infections. Yak milk and its derivatives also exhibit blood pressure-lowering effects, potentially aiding in the management of hypertension [6]. These potential benefits have led to increased interest in the use of yak milk and its products as functional foods and dietary supplements. Generally, the rich nutritional and functional properties of yak milk and its products make it a valuable food source that deserves further investigation and exploration. Previously, limited studies were available regarding yak milk; hence, this review focuses on the nutritional profile, chemical composition, and health benefits of yak milk, which might be helpful for future studies.

2. Nutritional profile of yak milk

Yaks are vital to human existence in high-altitude regions because they give locals fuel (dried yak dung), milk, meat, hide, and other necessities [12]. In addition, yaks are commonly employed in high-altitude regions as a source of power for transportation. Local herdsman can utilize yak milk straight or process it to make a variety of traditional dishes like butter, cheese, yogurt, and Tibetan tea. Yak milk seems to have a richer and more varied spectrum of nutrients than other forms of milk. Yak milk has high quantities of fat (5.5-7.5%), protein (4.0-5.9%), and lactose (4.0-5.9%) during the primary lactation period. According to [13], it is regarded as naturally concentrated milk.

As a result, yak milk ranks second only to cow and buffalo milk as one of China's primary economic milk sources [14]. The health of nomadic tribes in high-altitude areas may benefit from the special amino acids, fatty acids, high vitamin content, particular enzymes, and advantageous microbes present in yak milk [10]. According to the most recent research paper, there are several bioactive properties associated with yak milk and its derivatives, such as blood pressure lowering, antioxidant, anticancer, antibacterial, anti-fatigue, and constipation therapy capabilities. These results provide opportunities for the high-value use of yak milk [6].

3. Chemical composition of yak milk

Yak milk is a valuable food source with a unique chemical composition that makes it an attractive alternative to cow's milk. Its lower fat (5.5%) and lactose content (3.7%) and higher protein (5.9%), mineral, and immunoglobulin content make it a healthier milk option for people who are lactose intolerant or looking for a nutritious milk alternative. In addition to that, the pH of yak milk is slightly acidic, ranging from 6.3 to 6.8 [15].

3.1 Protein composition of yak milk

Proteins, which are necessary for the growth, development, and repair of bodily structures, are abundant in yak milk. About 80% of the total protein content of yak milk is made up of casein proteins. Yak milk's proteins can be broadly classified into two groups. α S1-casein, α S2-casein, β -casein, and κ -casein are among the casein varieties. The whey protein comprises immunoglobulins, serum albumin, lactoferrin, β -lactalbumin, and β -lactoglobulin [16]. β -casein is the dominant fraction in yak milk, analogous to that of human milk [17]. The Tibetan nomads use this milk for baby nourishment because of its high β -casein concentration (about 45%), which results in a decreased proportion of α s-casein (approximately 40%) and a slight rise in κ -casein (15%) [18].

3.2 Fat composition

There are several different fatty acids (FAs) in yak milk, including saturated and unsaturated FAs. Yak milk mostly contains saturated fatty acids (SFAs), which make up about 65%-75% of the total fatty acid content. Stearic acid (C18:0) and palmitic acid (C16:0) are the two saturated fatty acids that are most prevalent in yak milk. Alpha-linolenic acid (C18:3) and linoleic acid (C18:2) are the polyunsaturated fatty acids found in yak milk, while oleic acid (C18:1) is the most prevalent monounsaturated fatty acid. The concentration of linoleic acid (C18:2) in yak milk ranges from 2.5 to 5.0 g/100g fat [19]. At very high altitudes, conjugated linoleic acid (CLA) and polyunsaturated fatty acid (PUFA) are more abundant in yak milk fat [20].

Yak milk is thought to have a fatty acid composition profile that is generally advantageous to nutrition since it is high in monounsaturated and polyunsaturated fatty acids and low in saturated fatty acids [21].

3.3 Minerals

Yak milk is a very nutritious food that contains many important micronutrients, including calcium, phosphorus, fat, protein, and carbohydrates, that are necessary for human health. Yak milk contains a good amount of protein, which is essential for the body's tissue growth and repair as well as for maintaining muscle mass [22].

The amount of ash in cow and yak milk is roughly 0.8%. While the phosphorus concentration of yak milk was found to be similar to that of cow's milk, the major mineral contents of yak milk were found to be much greater than those of cow's milk. Yak milk has an average calcium level of 1545.45 mg/kg, compared to only one-fifth of the quantity in human milk [23].

Yak milk contains a higher iron concentration (0.57 mg/kg) compared to cow and human milk. However, the authors noted that because of the monthly variations in eating, the mineral content of yak milk generally seems to fluctuate significantly more than that of cow milk [24].

3.4 Vitamins

Numerous vitamins, including A, D, E, B12, and riboflavin, are abundant in yak milk and are necessary for preserving overall health [19]. Vitamin B6 and D levels in yak milk are higher than in other kinds of milk; this could be because yaks are typically found in high-altitude locations with prolonged exposure to UV radiation. Yak milk's nutrient content varies significantly between breeds and is not the same as that of conventional cow's milk. The nutritional content of yak milk varies according to the seasons and the dietary sources that yak eat. Vitamin levels are higher in yak or dairy cows fed an artificial diet [25].

The vitamin D content in yak milk was estimated to be around 0.005-0.015 mg/L, which is much higher compared to cow milk. According to [25], the higher amounts of vitamin D in yak milk as compared to cow milk are related to the grazing environment because yaks living on the Tibetan plateau are exposed to ultraviolet irradiation for long periods. The vitamin A concentration of yak milk is 42 micrograms per 100 ml of milk. The vitamin A content in yak milk is comparable to that of cow milk, which is roughly half that of human milk. Yak milk is a good source of vitamin C. The vitamin C content of yak milk is 15.6 mg/100 ml, compared to 2.5 mg in cow milk. Yak milk is a good source of vitamin B12, which ranges from 0.2-0.6 mg/L of milk [26].

3.5 Other nutritional components

Numerous essential and non-essential amino acids that are critical to human nutrition can be found in yak milk. Leucine, isoleucine, valine, lysine, methionine, phenylalanine, threonine, and tryptophan are among the essential amino acids present in yak milk. Alanine, arginine, aspartic acid, cysteine, glutamic acid, glycine, histidine, proline, serine, and tyrosine are among the non-essential amino acids found in yak milk [19].

Yak milk also contains sphingolipids, phospholipids, and some oligosaccharides [27]. These substances are not only beneficial for the growth and development of yak calves but also have certain health benefits for human bodies. There are also a large number of beneficial probiotics for human health in yak milk, such as *Lactobacillus rhamnosus* CY12 [28], *Lactobacillus plantarum* strain As21 [29], and *Kluyveromyces marxianus* PCH397. These probiotics and their metabolites have tremendous potential for promoting human health [30].

4. Health benefits of yak milk

Yak milk has various potential health benefits due to its high nutritional content and unique composition. It is an excellent source of protein, essential fatty acids, vitamins, and minerals, which can promote overall health and well-being. Yak milk may have potential therapeutic benefits for hypertension, as it contains peptides that have been shown to have anti-hypertensive effects. Yak milk has also been shown to possess antioxidant properties, which can help protect against oxidative stress and related health problems. Moreover, its fat contains higher levels of beneficial fatty acids, such as conjugated linoleic acid and omega-3 fatty acids, which have been linked to various health benefits, including reducing inflammation, improving heart health, and supporting brain function. Moreover, further research is needed to fully understand the potential health benefits of yak milk. Its unique composition and high nutritional content suggest that it may offer numerous health benefits and could be a valuable addition to a healthy diet [19].

5. Conclusion

Milk is an outstanding source of macro-elements, such as protein and essential fatty acids, and micro-elements like

vitamins and minerals, which are essential to maintaining good health and wellbeing. Yak milk is a nutrient-rich food that serves a variety of purposes. Yak milk, a delicacy uncommon in high-altitude areas, has significantly improved the health of the herdsman who live there. We examined the nutritional elements of yak milk, categorized and explained its functional functions and methods, and listed associated goods in this article. It is clear that yak milk is richer in minerals, has a more balanced amino acid composition, is higher in unsaturated fatty acids, and has more nutrients than typical cow's milk.

The functional value of yak milk is significantly increased by the numerous microorganisms found in it and its byproducts. All things considered, yak milk can be utilized as a high-nutrition food source for nutritional supplements and as a starting point for the creation of novel functional foods and health products. To thoroughly investigate the makeup and functional roles of its constituent parts, yak milk necessitates the broad use of new technologies and the collaborative encouragement of several disciplines. In contrast to other kinds of milk from mammals, people's knowledge about yak milk is still lacking, and further research is necessary to fully investigate its potential qualities and practical benefits.

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