



ISSN (E): 2277- 7695

ISSN (P): 2349-8242

NAAS Rating: 5.03

TPI 2021; 10(3): 374-378

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[www.thepharmajournal.com](http://www.thepharmajournal.com)

Received: 16-12-2020

Accepted: 02-02-2021

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## A review on comparison between bovine milk and plant based coconut milk

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### Abstract

On account of growing awareness of variety of vegetable milk such as coconut milk and also rising problem of lactose intolerance and environmental concerns in bovine milk, the consumers have shown interests in the coconut milk and other plant milk. Though, the replacement of bovine milk is not possible due to intrinsic compositional and functional characteristics in regard of controlling cardiovascular disease, diabetes, osteoporosis, cancer etc. The present article has been discussed and compared the compositional and functional differences between bovine milk and coconut milk. To counteract the misleading propagations and myths against bovine milk. In this review paper, an outline on bovine milk nutrients, bioactive and functional constituents and their health advantages are bestowed than the plant source coconut milk.

**Keywords:** Bovine milk, plant milk, coconut milk, physical, chemical, functional properties

### Introduction

At present in 2018-19, The bovine milk production of India is 187.7 million tonnes (DAHD &F, GOI, 2019). India ranks first among all the milk producing nations since 1998 with largest population of bovine milk in the world. However, India contributes 22.34% of the world's coconut production and is one of the major players in the world's coconut trade. India produces 15,730 million nuts annually next to Indonesia according to the Asian and Pacific Coconut Community (APCC), and India is the highest domestic consumer with 1494.4 million nuts annually. It is estimated that 25% of the world's coconut output is consumed as coconut milk (Gwee, 1988) [15].

The rising problems of lactose intolerance, milk allergies, environmental concerns, and other problems due to diets rich in cholesterol are leading toward a growing demand for dairy alternatives (Pistrich *et al.*, 2019) [30]. Plant milk is presented as a healthy, sustainable, and animal-welfare-friendly alternative to bovine milk (Rayburn *et al.*, 2019) [31]. Derived from the water extraction of legumes, nuts, or cereals, plant milk is completely free from animal-based ingredients (Chen, 1989) [4]. Plant milk is similar in appearance and taste to conventional milk and is used for the same purposes (Mäkinen, *et al.*, 2016) [23]. The available plant milk products on the market vary with respect to their nutrients, and it is common practice to add vitamins, minerals, and proteins to them (Mäkinen, *et al.*, 2016) [23]. The scarcity of fresh bovine milk supply in developing countries perhaps leads to the development of alternative milk from various sources (Adesola *et al.*, 2013) [1]. The oilseeds including groundnut, coconut, soybean and chestnuts have been used to a wide variety of milk-like products. The growing awareness of the nutritional benefits of plant based foods by health-conscious consumers has renewed interest in the development of vegetable milk and vegetable milk products (Diarra *et al.*, 2005; Onweluzo and Owo, 2005) [19, 29]. Mainly the coconut milk can play a vital role in balancing nutritional deficiency of diet. It is an important commercial crop in many tropical countries, contributing significantly to their economies (Sani *et al.*, 2014) [33]. Coconut is a staple ingredient in the diet of humans on many islands. Coconut milk is the natural oil-in-water emulsion extracted from the endosperm of mature coconut (Seow and Gwee, 1997) [34], which is characterized by its nutty flavour and its nutritional content (Seow and Gwee, 1997; Simuang *et al.*, 2004; Tansakul and Chaisawang, 2006) [34, 35, 40]. But bovine milk is a highly nutritious and multipurpose food consumed by almost everyone. Bovine milk provides essential nutrients and is an important source of dietary energy, high quality proteins and fats. It consists of nutrients like calcium, magnesium, selenium, riboflavin, vitamin B12 and pantothenic acid. In this article, the importance of bovine milk over the coconut milk has been highlighted to suppress the myths propagated against bovine milk.

## Functional and compositional differences between bovine milk and coconut milk

Bovine milk is a nutritionally rich, chemically complex bio-fluid consisting of hundreds of different components. The colour, flavour and composition of bovine milk depends on the species of dairy animal, its breed, age and diet, along with the stage of lactation, farming system and physical environment. FSSAI ((2015) [12] defines milk as the normal mammary secretion derived from complete milking of healthy milch animals. It should be free from colostrum. Milk which is adjusted for milk fat or milk SNF content or both, may also be named "milk" provided that the minimum and maximum limits for fat and SNF are as per the standards of milk.

However, no legal definition is available of coconut milk. It is a milky fluid obtained by the manual or mechanical extraction of fresh coconut endosperm with or without addition of water (De Leon and Delores, 2005) [8]. Countering the misleading beliefs of bovine milk, the functional and compositional differences of bovine milk with coconut milk are highlighted as under:

### (i) Chemical Compositional differences

**(a) Differences in Macronutrients:** In general, the gross composition of cow's milk is 87.0% water, 13.0% Total Solid, 4.9% lactose, 4% fat, 3.4% protein, and 0.7% minerals but in general, the gross composition of coconut milk is tabulated in Table No. 1 as under with the types of coconut milk:

**Table 1:** Classification of coconut milk and coconut cream

Product	Total Solids (%M/M) Min.- Max.	Non-Fat Solids (%M/M) Min.	Fat (%M/M) Min.	Moisture (%M/M) Max.	pH
Light coconut milk	6.6-12.6	1.6	5	93.4	5.9
Coconut milk	12.7-25.3	2.7	10	87.3	5.9
Coconut cream	25.4-37.3	5.4	20	74.6	5.9

(Source: CODEX STAN 240-2003) [6]

**(b) Differences in Micronutrients:** At a micronutrient level, bovine milk contains many bioactive compounds including

vitamins, minerals, organic acids, nucleotides, oligosaccharides, and immunoglobulins (Fox *et al.*, 2015) [11]. Bovine milk contains several essential nutrients and is an important part of dietary recommendations in many countries (Rozenberg, *et al.*, 2016) [32]. For more than 8000 years, cow milk has been an essential part of human nutrition (FAO, 2017) [10].

### (ii) Physico-Chemical Properties of Coconut milk and Cow milk

Gupta *et al.*, 2019 [14] have compared the Physico-Chemical properties of coconut milk with bovine milk. The pH in coconut milk has been found is 6.00 which was lower to standard cow's milk pH is 6.40. The specific gravity of coconut milk and standard cow's milk were found as 1.050 and 1.030 respectively. Solid-Not-Fat content was found in coconut milk as 1.20 percent which was lower than the cow's milk that contain 8.2 percent. Titrable Acidity was found as 0.09 percent and 0.15 percent in coconut milk and cow's milk collectively. The viscosity of coconut milk observed as 2.40 cp which was higher to cow's milk that contain 1.50 cp. The total soluble solids were found high in coconut milk as 14.06 percent in comparison to cow's milk that contain 12.50 percent.

Milk colour appears turbid and opaque due to light scattering by fat globules and casein micelles, while coconut milk appears in opaque and milky white colour and ranges in consistency from watery to creamy. Bovine milk has the natural sweet flavour which is due to the combined effect of its components while coconut milk has the natural nutty flavour (Seow and Gwee, 1997; Tansakul and Chaisawang, 2006) [34, 40].

**(iii) Physical Properties:** The range of physical properties for coconut milk (Gonzalez, 1990) [13] as well as cow milk and buffalo milk (Hamad *et al.*, 2010) [16] are presented in the following table 2.

**Table 2:** Physical Properties of coconut milk, cow milk and buffalo milk

Physical Properties	Coconut milk Range	Cow milk Range	Buffalo milk Range
Specific Gravity	1.0029-1.0080	1.028- 1.034	1.0301- 1.036
Surface Tension (dyne cm <sup>-2</sup> ) at 20°C	97.76-125.43	50	51
Viscosity (cP)	1.61-2.02	2.0	2.0
Refractive Index	1.3412-1.3446	1.3440-1.3485	1.3441-1.3486
pH	5.95-6.30	6.41- 6.79	6.56- 6.76
Freezing Point (° C)	-	-0.512 to -0.550	-0.512 to -0.550
Boiling Point (° C)	-	100.17	100.17

The bovine milk is comparatively less acidic and good rheological characteristics for high consumer acceptance and better tastes in mouth feeling.

### (iv) Functional differences as an impact on health

**(a) Establishing the gut microflora and impact on Immune System:** Bovine milk plays a key role in nourishment and hydration, it also has an essential role in establishing essential gut microflora and priming the immune system in all new born mammals (Murphy *et al.*, 2017) [27]. However, coconut milk contains a lipid called lauric acid, and many researchers believe that lauric acid can support the immune system.

**(b) Nutritional and Emulsifying characteristics:** Fat in bovine milk can be considered as an oil-in-water emulsion in

which the lipid fraction is mostly situated inside spherical droplets of the milk fat globules. The typical fatty acid pattern in fats of bovine milk results in a unique fatty acid profile, which affects to a great extent the physical and technological property. Milk fat contains some components in smaller amounts, comprising the polar lipids, glycerides and sterols. The polar lipids in milk products are interesting fraction from a technological and nutritional point of view. The milk polar lipids can be used as an emulsifying agent in various food products due to their amphiphilic nature. Sousa *et al.*, 2017 [37] have emphasised that the replacement of cow and buffalo milk with coconut milk will lead to reduce intake and absorption of calcium, minerals, proteins, certain vitamins and increased intake of salt, which is not desirable.

### (c) Differences in functions of proteins of bovine milk and coconut milk

Bovine milk contains about 32 g protein/litre (USDA, 2007) [42]. The bovine milk protein has a high biological value, and bovine milk is therefore a good source for essential amino acids. The biological activities of bovine milk pertain to antimicrobial characteristics and also abilities to absorption of nutrients, which will lead to act as growth factors, enzymes, hormones, antibodies and immune stimulants (Korhonen, *et al.*, 1998; Clare *et al.*, 2000) [21, 5]. The biological function of casein is to carry calcium and phosphate and to form a clot in the stomach for efficient digestion. The protein content and quality of cow's milk compared to most of the plant milk. Non-dairy milk beverages such as coconut milk vary in their nutritional profiles. The non-dairy beverages such as coconut milk should not be considered a nutritional substitute for cow's milk until nutrient quality and bioavailability is established (Singhal *et al.*, 2017) [36]. Bovine milk proteins, even proteins present at low concentrations, are likely to allergens. A few persons may have allergic to casein or whey proteins or to both. Milk allergy may arise in small children between the age of 0–3 years and it is predictable that 2 to 5% of the children has milk allergy (NAAF *et al.*, 2007) [28].

### (d) Stability differences

It has been reported that the fresh coconut milk spoils quickly after extraction because of its high content of oil, moisture and organic compounds, (Gonzalez, 1990) [13]. Thermal processing is a common method for extending the shelf life of coconut milk while cow milk only spoils due to coagulation of lactose into lactic acid. However, the stability of cow milk is superior to that of other types of bovine milk at same storage temperature. The heat treatment of dairy milk products leads to structural changes of proteins and main whey proteins are modified to lactulosyl residues (Meltretter *et al.*, 2007) [25]. The oil in water emulsion in coconut milk is stabilised by coconut protein but it is poor stable due to the insufficient quantity and quality of the protein present (Tangsuphoom and Coupland, 2005) [39]. Tangsuphoom and Coupland (2005) [39] have reported that the stability of coconut milk emulsions can be improved by homogenization with various surface-active agents like sodium caseinate, whey protein isolate (WPI), sodium dodecyl sulfate (SDS) and polyoxyethylenesorbitan monolaurate.

### (e) Differences in vitamins and minerals

Bovine milk content B complex vitamins are relatively unrelated to their intake because the amount synthesized by the rumen microbes are unregulated to the amount ingested (McDonald *et al.*, 2002) [24]. Coconut milk has fewer nutrients than dairy milk and most of the nutrients like vitamin B12, vitamin A and vitamin D are fortified. There is no standard practice for fortification with these nutrients in coconut milk because, each brand of coconut milk has a different nutrient combination. Bovine milk is a better source of potassium in comparison to coconut milk which may help the blood vessels and also reduce the blood pressure. Bovine milk contains two nutrients calcium and vitamin D that can help to protect against cancer. The bovine milk contains calcium about 1 g/litre. Dairy products provide more than half of the calcium in the diet (Insel *et al.*, 2004) [17]. It is reported that the calcium can protect the gut lining to treat the risk of colon cancer. Bovine milk is a good source of magnesium containing about 100 mg/litre milk (USDA, 2007) [42]. The

recommended diet of magnesium intake is 400 mg/day for men and 310 mg per day for women (Insel *et al.*, 2004) [17]. Bovine milk contains 50 ug folate per litre (USAD, 2007) [42]. Folates vitamin have to play a protective role against coronary heart disease and certain forms of cancer, but necessary evidence is not yet available (Staff *et al.*, 2005) [38].

**(f) Differences of Calorie intake and saturated fats/unsaturated fats in respect of CHD (Coronary Heart Disease):** Bovine milk protein content can be influenced by the high intake of dietary fat by lactating cow (Jenkins *et al.*, 2006) [19]. There are seasonal variations for the major fatty acids of bovine milk (Ledoux *et al.*, 2005) [22].

A cup of whole milk contains approximately 149 calories, 8 grams (g) of protein, and 8 g of fat. Similarly, some plant-based milks like soya, almonds, coconut etc. are highly nutritious, and many manufacturers offer products fortified with calcium and vitamin D.

While some people may choose coconut milk for its calorie count, more than half of those calories are from fat, most of it as saturated fat. It contains more saturated fat than reduced fat milk about 2%, it often has added sugar and has less than one gram of protein per serving.

It has been found that the bovine milk has large number of short chain and medium chain saturated fatty acids and also has a long chain unsaturated fatty acid such as oleic acid, linoleic acid. The high ratio of omega -3 fatty acid i.e. linolenic acid to the omega -6 (arachidonic acid) is beneficial to counter the Coronary heart diseases, which can be adjusted in bovine milk. Bovine milk fat contains a large number of fatty acids. The main saturated fatty acids, which account for 62–70% of the total fatty acids, are straight-chain molecules, which vary in length from 4 to 18 carbon atoms. The principal unsaturated fatty acid is oleic acid found in bovine milk (about 20% of the total) (Taylor, 2011) [41].

The unique nutritional value of bovine milk can be attributed to the presence of short-chain fatty acids and medium-chain fatty acids which are important sources of energy for the muscles, heart, liver, kidneys, blood platelets and nervous system. They have anti-inflammatory and antibacterial effects to boost natural immunity. They can also prevent obesity, ulcerative colitis, cancer, atherosclerosis and hypertension. Milk contains cholesterol, a lipid derivative which stabilizes and stiffens cell membranes, builds the cell cytoskeleton, protects nerve fibres and acts as a precursor of steroid hormones, bile acids and vitamin D3. Bovine milk lipids do not exert hypercholesterolemic or atherogenic effects in the human body (Jan, *et al.*, 2012) [18].

Some of the saturated fatty acids (SFA) in bovine milk have neutral or even positive effects on health. The saturated fatty acid (SFA) such as lauric-, myristic and palmitic acid have low-density lipoprotein (LDL) and high-density lipoprotein (HDL) cholesterol increasing properties (Mensink *et al.*, 2003) [26]. High intake of these SFA acids increases blood cholesterol levels (Mensink *et al.*, 2003) [26]. The coconut milk did not significantly increase levels of “bad cholesterol,” or low-density lipoprotein cholesterol, but it increased levels of high-density lipoprotein cholesterol or good cholesterol (Anna *et al.*, 2007) [3]. HDL cholesterol protects the heart and also removes LDL cholesterol from the blood.

**(g) Differences in added sugar in Coconut milk and naturally occurring milk sugar in bovine milk and impact on health:** The Dietary Guidelines for Americans recommend



limiting the amount of added sugar in our diet, which is an important consideration when choosing a beverage. Many varieties of coconut milk, like many other milk alternatives including flavoured and original almond and soy milk contain added sugar. The ingredient of plant milk includes cane sugar which indicates that the sugar has been added to the beverage from outside. However, bovine milk does not have added sugar; rather it has lactose, which occurs naturally. Due to rising concerns about health, lactose intolerance, and animal welfare, plant-based milk, and dairy alternatives are gaining popularity. Lactose intolerance is a condition where the body does not produce lactase, an enzyme it needs to break down a sugar called lactose that occurs in milk. However, the addition of lactase enzyme prevents the problem of lactose intolerance in bovine milk. The lactose concentration in bovine milk is around 53 g/litre (USDA, 2007) <sup>[42]</sup>. Fermented dairy products may be best option for drinking, because fermented milk contains lesser amount of lactose than fresh milk, and that it also may contain bacterial lactase that activated when the fermented milk reaches the gut (Kolars *et al.*, 1984) <sup>[20]</sup>. The control of balanced diet limits the intake of fat and high glycaemic component of food which can control the weight gain by consumption of bovine milk. Coconut milk contains medium-chain triglycerides (MCTs), which have linked with weight loss. MCTs stimulate energy to reduce body weight and waist size through a process called thermogenesis, or heat production. A lack of this stability may play a role in developing obesity by consumption of coconut milk.

### Conclusion

Compositional and functional differences between bovine milk and coconut milk have been discussed. Coconut milk has higher amount of saturated fat, higher added sugar and lesser protein contents. Because of high saturated fat, coconut milk is not considered as heart healthy. The unique nutritional value of bovine milk can be attributed to the presence of short chain saturated fatty acids, medium chain fatty acids and long chain unsaturated fatty acids, which are effective for the health of muscle, heart, liver, kidney and nervous system. Presence of minor elements like zinc, selenium, magnesium, calcium, iodine etc. and presence of vitamins A, D, E and K and water soluble vitamins B and its variant make the bovine milk unique to overcome diseases and to increase the bioavailability of protein and folate etc. In short, the natural bovine milk is always natural and artificial milk like coconut milk is always artificial.

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