

MILK COMPOSITION AND THERAPEUTIC PROPERTIES OF MARE, JENNY, CAMEL AND YAK

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India stands at first position in milk production in the world with 187.75 MT in 2018-19. The major milk-producing animals are buffaloes, cows and does, respectively with 49, 48 and 03 per cent contribution to the country's total milk production (BAHS, 2019). Milk from dairy animals are widely consumed by all the age groups of peoples' but the rising problems of milk indigestion, allergies and lactose intolerance in young and old age peoples and increase in the human population to beyond 1.55 billion in the year 2032-33 with the simultaneous increase in the demand for milk and milk products to 300-355 MT (NITI Aayog, 2018) has major concerns among scientists to identify non-cow milk sources with higher medicinal values, and milk composition identical or near-to-identical to dairy animals. This is in response to reduce health complications and meet the milk demands of the population. So far, non-cow milk sources are identified as the mare, jenny (she-donkey), camel and yak. The milk composition and therapeutic properties of non-cow milk sources have already been established and are reviewed in this article to identify the best possible aid to dairy animals'.

Milk composition

The milk composition is an inherited trait and varies between species and breeds. Among milk constituents, the most variable and costliest constituent are fat, unlike protein, solid-not-fat, lactose, minerals and water. In India, peoples' preference lies in the milk with high fat per cent and is the reason why milk with high fat per cent fetches high prices in the market. The details of average composition per 100g milk of mare, jenny, camel and yak are given in Table 1.

Table 1: Average composition per 100g milk of Mare, Jenny, Camel and Yak

Component (g)	Mare's milk	Jenny's milk	Camel's milk	Yak's milk
Water	89.50	89.80	87.20	83.10
Fat	1.30	1.10	4.50	6.50
Protein	2.10	1.70	3.50	5.10
Lactose	6.40	6.60	4.40	4.40
Minerals	0.40	0.40	0.70	0.80
Solid-not-fat	9.30	9.20	8.60	10.40
Total solids	10.50	10.20	12.80	16.90
Cholesterol (mg)	4.50	2.20	37.00	22.00
Calcium (mg)	89.00	68.00	143.00	131.00
Phosphorus (mg)	56.00	50.00	116.00	106.00
Saturated FA	0.40	0.40	2.40	3.90
Monounsaturated FA	0.30	0.20	1.40	2.20
Polyunsaturated FA	0.50	0.40	0.50	0.40
Lysozyme	0.055	0.10	0.0003	NA
Lactoferrin	0.082	0.037	0.27	NA

FA: Fatty acids; NA: Literature not available; References: Aspriet *al.* (2017), Kaskous and Pfaffl (2017), Pieszkaet *al.* (2016), Nikkhah(2011)

Therapeutic properties of milk

The search for easily digestible milk with fewer incidences of milk protein allergy and lactose intolerance has led to the discovery of health benefits from non-cow milk sources. The health benefits are due to the numerous bioactive components in milk that function beyond their nutritional value. The antioxidant, anti-inflammatory, anti-bacterial, anti-viral, anti-fungal, anti-diabetic, anti-ageing, immune-stimulant, gut health-promoting properties, etc. of milk make it an extraordinary drink for humans. The details of the therapeutic properties of milk of mare, jenny, camel and yak are given in table 2.

Table 2: Therapeutic properties of milk of Mare, Jenny, Camel and Yak

S. No.	Therapeutic property	Mare's milk	Jenny's milk	Camel's milk	Yak's milk
1.	Ease in digestion	Better Digestibility within 2 hours due to lesser casein proportions, more whey proteins (two times of cow milk) and soft curd formation in stomach.	The β -lactoglobulin in jenny milk is present as a monomer (dimer in other milk's). The monomer proteins are highly digestible thus, facilitates easy digestion of milk.	Better digestion as more lipolytic enzymes have access to small fat globules in milk.	Better digestibility due to balanced omega-3 to omega-6 fatty acid ratio in milk and higher proportions of β -casein, resulting in formation of soft coagulum in stomach.
2.	Anti-cow milk protein allergy	Due to less α S1-casein in milk and better digestibility of β -lactoglobulin.	Due to low milk α S2, κ -casein and β -lactoglobulin in milk.	Due to lack of β -lactoglobulin and A1 β -casein protein in milk.	Due to less α S1-casein in milk and better digestibility of β -lactoglobulin.
3.	Anti-cow milk lactose intolerance	Due to high content of lactose in milk, the milk is prone for lactose intolerances.		Due to low content of lactose in milk, the milk is suitable to people with lactose intolerances.	
4.	Anti-carcinogenic	Conjugated linoleic acid (CLA) in milk exhibits antioxidant and anti-cancer activity.	Milk α S1- and β -caseins, lysozyme, α -lactalbumin, β -lactoglobulin increase interleukin- β , 2, 6, interferon- γ , and tumour necrosis factor- α (TNF- α) secretion that suppress tumour proliferation.	The heavy chains of immunoglobulins in milk are used in immune therapy for cancer treatment; Antioxidant activity of milk lactoferrin and control of metastasis of cancer cells by milk peptidoglycan recognition protein exhibits anti-cancer activity.	Greater CLA content in yak cheese exhibits anti-carcinogenic effects. CLA <i>cis</i> -9, <i>trans</i> -11 and <i>trans</i> -11-C18:1 in yak cheese is respectively, 4.2 and 4.6 times greater than cow cheese.
5.	Anti-atherosclerotic	Low milk fat and cholesterol content and higher polyunsaturated fatty acids (PUFA) level prevents atherosclerosis.	Low milk fat and cholesterol content, omega-6 to omega-3 ratio and higher PUFA levels prevent the formation of atherosclerotic plaques.	Low milk fat and cholesterol level prevents atherosclerosis; The heavy chains of immunoglobulins in milk are used in immune therapy for multiple sclerosis treatment.	Richness of CLA (<i>cis</i> -9, <i>trans</i> -11-18:2 isomer), omega-3 fatty acids in milk maintains cholesterol level in blood and prevents atherosclerosis.
6.	Healthy drink	Milk is rich in whey protein and linoleic acid that benefits human health. Humans cannot produce linoleic	Due to low total bacterial count (<250 CFU/ml milk) and somatic cell count (<50x10 ³ cells/ml milk) in	High protein, vitamin-C, linoleic acid and other unsaturated fatty acids levels in milk makes it	Higher β and κ -casein and lower α S-casein in milk make it healthy for infants; Also, higher total essential amino

		acid;Also due to the less total bacterial count (300-58000 CFU/ml milk) and somatic cell count ($10-47 \times 10^3$ /ml milk) in milk among domestic animals.	raw milk;Also, high content of PUFA (linoleic and linolenic acids) makes it healthy drink for humans.	healthy food supplement for humans.	acids in milk, particularly methionine strengthen antioxidant defence system.
7.	Anti-hypertensive/ Reduce blood pressure	Higher levels of potassium in milk act as vasodilators and thus, prevent vasoconstriction and hypertension.	High content of linoleic and linolenic acids in milk prevents hypertension.	Hydrolysis of camel milk release angiotensin-converting enzyme inhibiting peptides. The peptides prevent conversion of angiotensin-I to angiotensin-II and thus, prevent vaso-constriction and hypertension; Also, higher potassium level in milk prevents hypertension.	Milk casein hydrolyses to produce anti-hypertensive peptides and angiotensin-converting enzyme inhibiting peptides that prevents vasoconstriction and hypertension; Higher levels of α -linoleic acids in milk also prevent hypertension.
8.	Cosmetic properties	Anti-bacterial and antioxidant activity of mare's milk makes it an active ingredient to skin creams, body lotions, shampoos and soaps.	Due to strong antioxidant and anti-ageing properties of jenny milk, it is included in the fairness creams, soaps and shampoos.	Milk is rich in α -hydroxy acids and zinc, frequently used in cosmetics for treatment of wrinkles, softening of skin and for overall improvement of skin quality; Also, anti-bacterial, anti-viral, anti-fungal, anti-inflammatory and antioxidant properties of milk lactoferrin make it an active ingredient in cosmetics preparation.	Milk is rich in zinc, an active ingredient in cosmetics for treatment of skin allergies and ailments and providing glow to the skin; People apply yak butter on face as yak butter is rich in L-tyrosine that converts into melanin by tyrosinase. Melanin facilitates pigment formation in skin and protects skin from UV rays damage.
9.	Immune-stimulant	Milk lactoferrin (10 times higher than cow milk), lysozyme and immunoglobulin-G stimulate immune system.	Donkey milk induces immunoglobulin-G secretion and the release of interleukins (IL12, IL1 β and IL10) and TNF α , important for the treatment of immune related diseases; Milk	Due to richness of milk in zinc, vitamin-C and iron (3 times more vit.-C and 10 times more iron than cow milk); Milk lactoferrin, lysozyme, immunoglobulin-	Richness of CLA (<i>cis</i> -9, <i>trans</i> -11-18:2 isomer) in milk modulates the immune system; Also, consumption of yak yogurt rich in Bifidobacterium and Lactobacillus spp. as probiotic strains enhances the

			lactoferrin, lysozyme, lactoperoxidase and whey protein is also known to boost immunity.	G and A, lactoperoxidase and camel whey protein also boosts immunity; Also, higher levels of magnesium aids biosynthesis of glutathione that enhance antioxidant defence system.	immune response.
10.	Anti-diabetic	Mare's milk reduces the dose of insulin and improves the glycaemic index.	Lysozyme and α -lactalbumin in milk helps in curing type-2 diabetes in humans.	Camel milk contains insulin that acts as anti-hypoglycemic agent and regulates B-cells function.	Greater CLA content in yak cheese exhibits anti-diabetic effects.
11.	Anti-dermatitis/ eczema	Due to lesser amounts of interleukin-16 in milk, responsible for occurrence of dermatitis; Also lactoferrin, lysozyme and calcium in milk work together as an anti-inflammatory, anti-fungal and anti-bactericidal substance.	NA However, anti-inflammatory property of omega-3 fatty acids, lactoferrin and lysozyme is assumed to exhibit anti-dermatitis effect.	Due to richness of milk in α -hydroxy acids, lysozyme and lactoferrin that exhibits anti-inflammatory property.	Milk is rich in zinc, an active ingredient for treatment of skin ailments.
12.	Anti-ulcerative	Mare's milk improves the secretory and motor functions of stomach which remarkably declines the size of ulcers.	NA But jenny milk could exhibit anti-ulcerative property as it release high amount of nitric oxide that stimulates mucus production, inhibits the adherence of neutrophils to the endothelial cells, and increases the blood flow to the mucus membrane thus, curing ulcers.	Ability of milk to release more nitric oxide and richness in magnesium and zinc that reduces the oxidative stress, is known to cure ulcers.	Richness of yak yogurt in probiotic strains (Bifidobacterium spp. and Lactobacillus spp.) is reported to treat peptic ulcers.
13.	Reduce respiratory diseases	Anti-inflammatory and anti-microbial properties of milk reduce problems of asthma, pneumonia and bronchitis.			

14.	Reduce liver diseases	The sublimated mare milk supplement is reported to cure chronic viral hepatitis C.	The antioxidant, anti-bacterial and anti-inflammatory property of milk enables healthy functioning of liver and cures jaundice and the inflammations of liver.	The antioxidant, anti-bacterial and anti-inflammatory property of milk enables healthy functioning of liver and cures jaundice and the inflammations of liver;Also, anti-viral property of milk lactoferrin inhibits hepatitis B and C virus by preventing the entry of the virus into the cells.	Richness of Yak yogurt in probiotic strains (Bifidobacterium spp. and Lactobacillus spp.) prevents hepatic encephalopathy.
15.	Alleviates tuberculosis (TB)	Koumiss, a fermented milk product is reported to cure TB.	Can be due to the immunoglobulins in milk, however, research is still needed.	Milk immunoglobulins acts against TB & paratuberculosis.	Yak is susceptible to bovine TB therefore yak milk is not given to TB patients.
16.	Alleviates anaemia	Due to higher concentrations of iron in milk.	NA	Due to higher concentrations of iron in milk.	Due to higher concentrations of iron in milk.
17.	Promotes gut health	Enzymes (lysozyme and lactoferrin) in milk selectively stimulate the growth of beneficial bacteria (Lactococcus, Leuconostoc, Streptococcus and Enterococcus spp.) in gut that influences the diversification of gut micro flora and limits the growth of unwanted bacteria.	Milk is rich in concentration of lysozyme that shows resistance to the degradation by gastro-intestinal enzymes and exhibits anti-bacterial property against <i>Staphylococcus aureus</i> and <i>Listeria monocytogenes</i> , and promotes multiplication of beneficial bacteria Lactobacillus and Bifidobacterium spp.	Camel milk inhibits growth of <i>Escherichia coli</i> , <i>Klebsiella pneumoniae</i> , <i>Clostridium</i> spp., <i>Helicobacter pylori</i> , <i>Staphylococcus aureus</i> , <i>Candida albicans</i> , etc. and promotes gut health.	Milk is rich in probiotic strains (Lactobacillus spp. and Bifidobacterium spp.) that blocks gastro-enteric pathogens and cures intestinal dysfunction.
18.	Cures Crohn's disease	Based on bactericidal and immunological components of mare's milk.	A high level of anti-microbial peptides in milk confers anti-inflammatory property to milk and thus, supports curing of Crohn's disease.	Lactoperoxidase, lysozyme, lactoferrin and peptidoglycan supports curing of Crohn's disease.	NA
19.	Improves bone health	Due to higher mineral concentrations (potassium, iron, calcium and magnesium) in milk, osteoporosis and other bone ailments	High content of lactose in milk facilitates the intestinal absorption of calcium, essential for infant's bone mineralization; Improvement in	Milk lactoferrin has cartilage protective and anti-arthritis activity. The protein is an iron chelating protein that removes free	Richness of CLA (<i>cis</i> -9, <i>trans</i> -11-18:2 isomer), calcium, phosphorus, zinc and iron in milk improves bone mineralization.

		can be prevented.	bone health is also due to the beneficial health effects of omega-3 fatty acids.	iron from the joints of arthritic patients and improves arthritis;Also, bones are supported by high levels of potassium, magnesium, iron and vitamin B in milk.	
20.	Cures Autism	NA	NA However, jenny milk is rich in Taurine (9 times of cow milk), known to promote normal functioning of the nervous system, and therefore, could be of interest in curing autism.	Camel milk strengthens the antioxidant defence by increasing the levels of glutathione, superoxide dismutase and myeloperoxidase in plasma and reduces the effects of oxidative stress to improve the psychological symptoms of autism;Also, milk decrease serum level of 'thymus and activation-regulated chemokine' (TARC) in autistic children.	NA But, the whey proteins in yak milk exhibit psychomodulatory activities and could improve the psychological symptoms of autism.
21.	Cures Alzheimer's disease	Due to the availability of essential fatty acids in milk.	Due to beneficial health effects of omega-3 fatty acids.	The heavy chains of immunoglobulins in milk are used in immune therapy for Alzheimer's treatment.	NA
NA- Literature not available; References: Dorjiet <i>et al.</i> (2020), Equilac (2020), Li <i>et al.</i> (2020), Galali and Al-Dmooor (2019), Hazraet <i>et al.</i> (2019), Anonymous (2018), Li <i>et al.</i> (2018), Yvonet <i>et al.</i> (2018), Madhusudanet <i>et al.</i> (2017), Rasheed (2017), Kula (2016), Pieszkaet <i>et al.</i> (2016), Zibae (2015), Guoet <i>et al.</i> (2014), Li <i>et al.</i> (2011), Schubert <i>et al.</i> (2009), Anonymous (1999), Sharmanovet <i>et al.</i> (1981).					

Conclusion

Milk from non-cow milk sources was rarely the preferred choice, but in the last few decades has gained popularity due to their therapeutic properties. The therapeutic properties exhibited by non-cow milk sources are almost similar, and the only difference that exists among the milk sources is the concentration of milk components that exhibit these properties.

In India, milk with high fat per cent is preferred and therefore, camel and yak milk could be a possible aid to the dairy animals', whereas; in other countries, where people prefers milk with less fat per cent, mare and jenny milk could be a possible aid to the dairy animals'.

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