

Guidance Document

Donkey Milk – It's Scientific Profile

Background: The National Research Centre on Equines also has been conducting research on Donkey milk. Donkey milk is not listed as food item till date in India and Donkey milk though it is being used as a substitute of human milk in several countries. Now-a-days, the consumers' interest in donkey milk is escalating in European countries due to its compositional similarity to human milk, with good tolerability and palatability. Hence, in western countries, donkey dairies are emerging to produce an alternative milk source for human infants. Also, there is enhanced interest of consumers for donkey milk in different states of India.

Introduction: Donkey, (*Equus asinus*), also called burro or domestic ass belongs to the horse family, Equidae, and descended from the African wild ass (*Equus africanus*). It is known to have been used as a beast of burden since 4000 BC. It is a rustic, undemanding, and easily adaptable animal. Donkey population in the world is about 40 million, which is decreasing drastically. The total donkey population in India currently stands at 1.12 lakhs (Livestock Census 2019); a decline of 61.23% compared to 2012 Census. The reasons attributed for such a decrease in donkey populations are ignorance of the animal for transport purpose, and illegal slaughtering for meat and cosmetic purposes.

Donkey Milk – History: Female donkeys (jennies) have been known for thousands of years for their valuable milk. Hippocrates (460–370 BC) was the first to write about the medicinal properties of donkey milk. In the 19th century, the French Dr. Parrot breast-fed orphaned babies directly on female donkeys, as DM is most similar to human breast milk. DM was also sold well into the late 20th century to feed and heal orphaned infants and cure weak and sick children, as well as the elderly in France.

Donkey - Lactation Details: Donkey mammary gland's capacity is limited to 2.5 L. Hence, the lactating animal needs to be milked more frequently; it is recommended to

milk 3 times a day with a minimum interval of 3 hours to get an optimum yield. Yield of donkey is low with a mean of 1.57 ± 1.12 kg/day. Gestation Period in donkeys is about 12 months with a lactation Length of about 200 days. Life Expectancy of donkeys is about 15 years and age at maturity is about 2 years.

Milk yield in donkeys is influenced by many factors, such as breed, management of dams and foals, feeding, stage of lactation, lactation number, foaling season, milking procedure, number of milkings per day. Donkeys foaling in winter and in summer produced more milk than those foaling in spring and autumn. Average amount of milk yield for morning milking was statistically lower than that for afternoon milking (549.2 mL vs. 949.3 mL). Parity affects the daily milk yield and parity 3 donkeys produced 22% more milk than parity 4 donkeys (3.30 vs. 2.70 kg/day).

Donkey Milk – Sensory Properties: Reports indicate that donkey milk is palatable and sweet in taste. In a DST sponsored project at College of Dairy Engineering, Bengaluru, Nayaka et al (2020) reported mean scores value for the sensory attributes such as appearance, smell, consistency, taste and overall acceptability were 8.10 (like very much), 7.10 (like moderately), 7.00 (like moderately), 8.00 (like very much) and 8.00 (like very much), respectively.

Physico-chemical Properties: Donkey milk is slightly alkaline (mean pH:7.2) and low acidity (mean % lactic acid 0.052), which is similar to that of human milk (mean pH: 7.2; mean % lactic acid 0.06); on the other hand, bovine milk is slightly acidic (mean pH; 6.7 and mean % lactic acid: 0.16). The low acidity in donkey milk is due to lower content of caseins and phosphates. Donkey milk is also characterized with small fat globule size (2 μ), compared to human and bovine milk (4 μ).

Gross Composition: Several reports indicate that composition of donkey's milk closely resembles human milk, except the fat content, which is considerably lower in the former. Further, donkey milk is low in energy. The composition of milk of donkey, human, cow and is shown in the following Table 1.

Table 1: Gross Composition of Milks of Donkey, Human, Cow and Buffalo

Parameter/100 g	Donkey	Human	Cow	Buffalo
Total Solids, g	8.8 – 11.7	11.7 – 12.9	12.0 – 13.0	16.0 – 19.0
Solids not Fat , g	8.5 – 9.9	8.4 – 8.9	8.5 – 9.1	9.0 – 10.0
Fat, g	0.3 – 1.8	3.3 – 4.0	3.5 – 3.9	7.0 – 9.0
Protein, g	1.5 – 1.8	0.9 – 1.7	3.1 – 3.8	3.3 – 3.6
Lactose, g	5.8 – 7.4	6.3 – 7.0	4.4 – 4.9	4.5 – 5.0
Ash, g	0.3 – 0.5	0.2 – 0.3	0.7 – 0.8	0.8 – 0.9
Energy, Kcal	32 - 54	58.5 - 71	62 - 70	94 - 115

Microbiological Properties: A Somatic cell count <50,000 mL was reported in fresh donkey milk, which is considerably lower than that observed in cow milk. No clinical or sub-clinical mastitis was reported in donkeys, which was attributed to their small udder, anatomical structure of the mammary gland, and presence of antibacterial substances. Fresh raw bulk milk was reported to contain a total bacterial count of 2.71 Log CFU/mL at 32°C; after 8 days of storage at 8°C, TBC and *Enterobacteriaceae* increased by 3 logs. Pathogenic bacteria such as *Salmonella* sps., *E.Coli*, *C.perfrengens*, coagulase positive *Staphylococci*, yeasts and molds were not observed in fresh milk and stored samples. Presence of high levels of antibacterial substances viz., lysozyme, lactoferrin facilitated a better microbial quality of donkey raw milk.

Nutritional Properties: Donkey milk is low in calories (~40 Kcal) and hence, recommended in diet therapy; however, it requires supplementation, if infants and children need to be fed. Donkey milk is low in protein levels; but has essential amino acid content similar to that in human milk. Ratio of casein : whey proteins is lower in donkey milk than that in cow milk and resembles that of human milk. It is reported that donkey milk proteins are easily degraded and digested in GI tract; low levels of casein help formation of soft curd. Lysozyme, an antimicrobial substance present in high

content in donkey milk is not digested in the human stomach and is passed on to intestine to exert selective action against gut bacteria (pathogenic). Lactose content of donkey milk is similar to human milk, besides providing galactose, required for brain growth, lactose aids in mineral absorption, serves as substrate for gut bacteria, and acts as prebiotic for the gut microflora. Sialylated oligosaccharides content on donkey milk is reported to be lower than human milk and higher than cow milk; these substances serve as prebiotic, possess antimicrobial activity and stimulate immune system.

Donkey milk has small size fat globules ($\sim 2 \mu$), which provide large surface area and hence, are easily digestible. Donkey milk is low in saturated fatty acids (SFA) and high in unsaturated fatty acids (UFA) with ratio of SFA:UFA lower than cow milk. Donkey milk is also high in 18:2 (essential fatty acid) and n-3 fatty acids, with low ratio of n3 : n6. Content of eicosapentanoic acid (EPA) is reported to be higher in donkey milk than that in human milk and docosahexanoic acid (DHA) content is higher than that in cow milk. Triglyceride structure of donkey milk fat is similar to that of human milk fat facilitating its easy digestion. Mineral content of donkey milk is low and thus, reduces load on kidneys in infants. Donkey milk is reported with higher content of vitamins C and D.

Shelf-life: Raw Donkey Milk is reported with higher shelf-life due to the presence of antimicrobial substances and kept well at 4°C for 4 days; 10 h at 37°C.

Therapeutic Properties: Donkey milk is designated as 'pharma food', 'functional food', 'nutraceutical', 'elixir of youth' and is considered both as pediatric and geriatric food. Cow milk protein allergy (CMPA), with $\sim 3\%$ of occurrence in children below 3 years causes adverse cutaneous, intestinal and respiratory symptoms, and even anaphylactic reaction. Hence, donkey milk is long used as alternative to human milk for infants without Mothers' Own Milk (MOM). Recent reports also show hypoallergenic in nature in infants with IgE mediated Cow Milk Protein Allergy (Ig E CMPA) and Cow Milk caused Food Protein Induced Enterocolitis Syndrome (CM-FPIES). Reasons for hypoallergenic principles of donkey milk are low casein and β -lactoglobulin, low casein : whey protein

ratio, structure of casein and whey protein and easy digestibility of donkey milk proteins. Donkey milk is reported to have high antimicrobial property due to the presence of high levels of lysozyme, lactoferrin and lactoperoxidase. Donkey milk It is also reported to depress tumor proliferation, reduce inflammation, reduce the incidence of atherosclerosis and cardiovascular diseases, and be good for patients of irritable bowel syndrome (Crohn's disease and ulcerative colitis). It was used for cosmetic health; it is reported that it improves skin condition due to its antioxidative, antiaging, and antifungal (against dermatomycotic fungi - *T.mentagrophytes* and *T. rubrum*) activities.

Processing Limitations: It was reported that protein sedimentation occurred in donkey milk after heating at 75 °C for 10 min. Donkey casein micelles were more sensitive to heat treatment than whey protein. Poor colloidal stability and a highcalcium environment caused the heat instability. Donkey milk also lacks the ability for gravitational creaming due to smaller size globules and lack of euglobulin. Difficulty in preparation of fermented dairy products was also reported due to low total solids and low casein, and presence of high levels of antibacterial substances. However, it is used in the preparation of cheese (pule), Koumiss (fermented drink) and certain probiotic foods. Due to its therapeutic benefits, attempts are being made for valorization of donkey milk.

Safety and Toxicity: No safety and toxic concern of consumption of donkey milk are reported. In fact, CSIR-CFTRI reported no safety concerns on the consumption of donkey milk.

Limitations on the use of Donkey Milk: Lack of Legislation/approval for use of donkey milk as food, social taboo and low milk yield are considered as factors limiting its commercialization.

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