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Analysis of Nutritional Comparisons of Donkey Milk with Cow and Human Milk: Economic Implications

Mujefa Mulla and Dharma Guru Prasad M.P.*

Department of Zoology, BLDEA's SB Arts and KCP Science College, Vijayapura 586103, Karnataka, India

**Corresponding Author*

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Abstract: The study examines key nutrient attributes such as protein levels, lactose levels, and appealing micronutrients across all three types of milk- donkey, cow and human. Studies have shown that donkey milk has a different composition than other types of milk, with the protein and fat content being more similar to that of human milk in comparison to cow milk. Nonetheless, economic analyses indicate that there may be opportunities for niche markets to develop within the dairy sector, especially with infant formula production and functional foods manufacturing. However, limitation in donkey milk production and higher cost compared to conventional dairy products are pointed out.

Keywords: Donkey milk, Cow milk, Human milk, Nutritional composition

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Introduction

Human diet cannot be complete without milk as it is vital for growth and development of infants. Cow milk is considered and consumed as the primary type of milk. In recent years alternative source of milk which is having the more nutritional value is getting interest because of its nutritional value and potential health benefits such type of importance has been observed in donkey milk (Uniacke-Lowe *et al.*, 2010).

The nutritional profile of donkey milk also shares similarities with human milk. Donkey milk

is rich in bioactive compounds, whey proteins, low fat but high lactose content and low protein (Uniacke-Lowe *et al.*, 2010; Li *et al.*, 2017; Altomonte *et al.*, 2018; Malacarne *et al.*, 2019; Massouras *et al.*, 2020; Bhairav, 2020; Ravinder *et al.*, 2021; Vincenzetti *et al.*, 2021; Papademas *et al.*, 2022).

The present study examined key nutrient attributes such as protein levels, lactose levels, and appealing micronutrients across all three types of milk- donkey, cow and human.

Materials and Methods

Different types of parameters such as amino acid contents, protein, fat, lactose, cholesterol and some minerals etc., were analysed in donkey milk, cow milk and human milk by standard methods.

Results and Discussion

Amino Acid Comparison

The following table depicts the amino acid compositions in three different milk samples:

Amino Acid Contents	Donkey Milk (%)	Cow Milk (%)	Human Milk (%)
Leucine	10.1	8.5	10.1
Isoleucine	4	4.2	5.8
Valine	4.9	0.76	5.8
Lysine	7.5	8.1	6.2
Tryptophan	1.6	1.5	1.8
Threonine	4.5	4.5	4.6
Phenylalanine	5	4.8	4.4
Histidine	3.3	3	2.3
Taurine	0.87	0.097	6.117
Casein	41.4	2.8	0.5
Protein	1.7	3	1

- **Leucine:** Donkey and human milk have same leucine content (10.1), while cow milk is slightly lower (8.5).
- **Isoleucine:** Human milk have highest isoleucine content (5.8), followed by cow milk (4.2) and donkey milk (4).
- **Valine:** Donkey (4.9) and human milk (5.8) have almost identical valine content, while cow milk is significantly lower (0.76).
- **Lysine:** Cow milk has the highest lysine content (8.1), closely followed by donkey milk (7.5), with human milk having a lower value (6.2).
- **Tryptophan:** The tryptophan content is similar across all three milk types.
- **Threonine:** The threonine content is similar

across all three milk types.

- **Phenylalanine:** The phenylalanine content is almost similar across all three milk types.
- **Histidine:** Donkey milk has the highest histidine content (3.3), followed by cow milk, with human milk having a lower value (2.3).
- **Taurine:** Human milk has a significantly higher taurine content (6.117) compared to donkey (0.87) and cow milk (0.097).

Protein and Casein Content

- **Protein:** Cow milk has the highest protein content (3%), followed by donkey milk (1.7%), and human milk having the lowest (1%).
- **Casein:** Donkey milk has a higher casein content (41.4) compared to cow (2.8) and human milk (0.5). However, the value for donkey milk seems unusually high and it is important to verify this value from other sources, as casein typically makes up a smaller percentage of total protein in donkey milk compared to whey proteins (Guo *et al.*, 2007).

Implications for Nutritional Value

- The amino acid profiles suggest that donkey and human milk are more similar in some aspects (leucine, valine) compared to cow milk.
- Human milk's high taurine content is notable, as taurine is important for infant development.
- Cow milk's higher protein content makes it a more concentrated source of amino acids overall.

The following table illustrates data comparison of the composition of donkey, cow, and human milk, specifically focusing on moisture, ash, fat, and lactose content.

Parameter	Donkey Milk (%)	Cow Milk (%)	Human Milk (%)
Moisture	92.5	87	87.8
Ash	0.42	0.7	0.25
Fat	1.2	3.2	3.5
Lactose	5.9	4.6	6.3

Summary of the key differences

- **Moisture:** Donkey milk has the highest moisture content (92.5%), followed by human milk (87.8%), and cow milk (87%).
- **Ash:** Cow milk has the highest ash content (0.7%), followed by donkey milk (0.42%), and human milk (0.25%).
- **Fat:** Human milk has the highest fat content (3.5%), followed by cow milk (3.2%), and donkey milk (1.2%).
- **Lactose:** Human milk has the highest lactose content (6.3%), followed by donkey milk (5.9%), and cow milk (4.6%).

As per the observations made in the following data donkey milk is having closer similarities in composition (Altomonte *et al.*, 2018; Papademas *et al.*, 2022).

The following table depicts a comparison of fatty acid and cholesterol content in donkey, cow and human milk:

Parameters*	Donkey Milk	Cow Milk	Human Milk
Oleic acid	135	26.3	33.6
Linoleate	121	2.9	6.4
Linolenic acid	27	1	1.7
Cholesterol	8.6	15	11

*Each value is expressed as mg/100g

- **Oleic Acid:** Donkey milk has a higher oleic acid content compared to cow and human milk.
- **Linoleate:** Donkey milk also has a much higher linoleate content compared to the other two milk samples.
- **Linolenic Acid:** Donkey milk has a higher linolenic acid content compared to cow and human milk.
- **Cholesterol:** Donkey milk has the lowest cholesterol content compared to other two milk samples.

The following table depicts comparison between calcium, phosphorous and vitamins in donkey, cow and human milk:

Parameters	Donkey Milk	Cow Milk	Human Milk
Ca (mg/100g)	68.9	122	33
P (mg/100g)	40	93	14
Vitamin A (mg/100g)	160	126	190
Vitamin B1 (µg/100 g)	12	45	17
Vitamin B2 (µg/100 g)	26	160	36

- **Calcium (Ca):** Cow milk has the highest calcium content when compared to donkey milk, and human milk.
- **Phosphorus (P):** Similar to calcium, cow milk has the highest phosphorus content, when compared to donkey milk and human milk.
- **Vitamin A:** Human milk has the highest vitamin A content when compared with other two milk samples.
- **Vitamin B1:** Highest amount of vitamin B1 has been observed in cow milk and lowest in donkey milk.
- **Vitamin B2:** Highest amount of vitamin B2 has been also observed in cow milk and lowest in donkey milk.

Conclusion

The comparison of nutritional composition in donkey, cow, and human milk is to understand their significant role on human health.

- **Donkey Milk:** The high level of moisture and lactose content will be potentially beneficial for the growing infants because the cow milk may produce allergens or digestive issues.
- **Cow Milk:** Cow milk's high protein, calcium, and phosphorus content make it an excellent choice for supporting bone growth and overall development. But, the higher level of allergenicity has been also observed in human individuals.

- **Human Milk:** The highest amount of lactose content with vitamin A is good source of nutrition for the growing infants but the percentage of cholesterol is more when compared with the donkey's milk.

Ethical Statement

No animal or microbes have been sacrificed for this study, hence Ethical Approval not required.

Author Contributions

Each author has contributed equally in designing the research, conducting thorough analysis, drafting the manuscript, and refining its content. All authors have read and agreed to the published version of the manuscript.

Conflict of Interest

The authors declare no conflicts of interest.

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