VOLUME 9 ISSUE 2 2023

ISSN 2454 – 3055

INTERNATIONAL JOURNAL OF ZOOLOGICAL INVESTIGATIONS

Forum for Biological and Environmental Sciences

Published by Saran Publications, India

International Journal of Zoological Investigations Vol. 9, No. 2, 983-989 (2023)

International Journal of Zoological Investigations

Contents available at Journals Home Page: www.ijzi.net

Editor-in-Chief: Prof. Ajai Kumar Srivastav

Published by: Saran Publications, Gorakhpur, India

ISSN: 2454-3055

Nutritional Analysis of Badri Cow Milk Collected from District Nainital and its Comparison with Exotic Cow Milk and Packaged Marketed Milk

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Received: 2nd September, 2023; **Accepted:** 6th October, 2023; **Published online:** 7th November, 2023

https://doi.org/10.33745/ijzi.2023.v09i02.110

Abstract: India is globally known as an agricultural country where animal husbandry plays a vital role in the socioeconomic development of the people. India owns the highest number of cattle and buffaloes worldwide. Therefore, livestock plays a vital role in the national economy. The livestock census of 2019 revealed that in comparison to the National figure, Uttarakhand shares 0.96% cattle, 0.79% buffaloes, 0.38% sheep, 0.92% goats, 0.20% pigs, and 0.59% poultry in terms of livestock. The Badri cow is found only in the hill districts, currently known as the State Badri cow, and was earlier known as the Pahadi Gai. Badri cow is a small, cattle having various colors black, brown, and grey, with an average weight of 200-250 kg. Badri cows provide high-quality milk which is full of nutritional components. This cattle graze on various shrubs and herbs of the forest; therefore, the nutritional content of milk varies from other breeds. The present study was conducted in the Nainital and districts of Uttarakhand. The milk samples were collected in a sterile bottle, carried out in coolant packs to the laboratory, and preserved at -20°C for further investigation. The parameters, i.e., Adulteration, Crude Protein, Fat, Total solid, Solid not fat, and Ash, were estimated. The present investigation yielded negative adulteration results with 1-4% Crude Protein, 1-8% fat, 11-17% total solid, 8-10% Solid Not Fat, and 0.1 -1% ash in all the milk samples. This preliminary study explains that Badri cow milk is used by people for their consumption, rarely for commercial purposes, and is an excellent source of a nutritional diet for infants.

Keywords: Badri cow, Nutrition, Livestock, Micronutrients, Protein, Fat

Citation: Arya Mansi, Bora Shikha and Bisht Satpal Singh: Nutritional analysis of Badri cow milk collected from District Nainital and its comparison with exotic cow milk and packaged marketed milk. Intern. J. Zool. Invest. 9(2): 983-989, 2023.

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Introduction

The Badri cow is an indigenous breed of Uttarakhand mainly found in the state's steep terrain (Nautiyal and Dubey, 2020). The Badri cow is said to be fortunate and its milk is used for religious and nutritional purposes. These cattle feed on natural vegetation and dwell in Uttarakhand's highland areas, i.e., natural and pollution-free environment. Badri cow breed is the

Uttarakhand state's first certified breed (ICAR National Bureau of Animal Genetics Resources (NBAGR) Karnal, the accession number of the Badri breed is INDIA-CATTLE-2400-BADRI-03040). According to the Uttarakhand State Council for Science and Technology and IIT Roorkee, the Badri cow's milk has about 90% A2 beta-casein Protein, making it one of the highest in any indigenous kind. Cow milk is of primary significance for human health due to its high intake and various derived products (Zentai *et al*., 2023). This cattle's daily milk output range varies from 1 to 3 liters.

According to the most recent estimate, this breed's population in Uttarakhand is around 16 lakhs. The government has launched several initiatives, including the Rashtriya Gokul Mission, the National Kamdhenu Breeding Centre, the Central Herbal Registration System, and the National Dairy Plant. In 2012, a cattle breeding centre in Nariyal village of Champawat District was established to preserve this unique breed, and it now houses roughly 150 cows. NBAGR is committed to working with its directive of identifying, evaluating, characterizing, conserving, and utilizing the country's livestock and poultry genetic resources (https://saveindiancows.org/badri).

Cow milk consumption varies worldwide, averaging 10–212 kg per person yearly. Milk contains 18 of 22 essential nutrients, including a variety of bioactive peptides and fatty acids such as caseins, whey proteins, polar milk lipids (MPL), α-linolenic acid (ALA), conjugated linoleic acids (CLA), palmitic acid, lactose and other minor constituents (i.e., calcium, phosphorous, magnesium, and vitamin D) which have a substantial impact on human metabolism and health (Zhang *et al*., 2021). The higher consumption of milk and dairy products reduces the risk of childhood obesity and improves body composition in adults (Guetouache *et al*., 2014; Thorning *et al*., 2016; Poppitt, 2020). Cow milk is the most comprehensive as this milk has a crucial significance in human nutrition (Barłowska *et al*., 2011).

The present study was conducted in the Nainital and districts of Uttarakhand. The milk samples were collected in a sterile bottle, carried out in coolant packs to the laboratory, and preserved at -20℃ for further investigation. The parameters, i.e., Adulteration, Crude Protein, Fat, Total solid, Solid not fat, and Ash, were estimated.

Materials and Methods

Description of the study sites:

The Present study was conducted in the Himalayan region, providing valuable insights into its ecological diversity, including its flora and fauna. The milk samples were collected from Village Babiyar, District Nainital, Uttarakhand. The study site is located at an altitude of 1384 m asl, Latitude 29° 17' 549 and Longitude 79°41' 291. The main fodder species grown in this area are *Grewia optiva*; *Ficus roxburghii*; *Celtis australis*; *Quercus leucotrichophora*; *Bauhinia variegata*; *Quercus semecarpifolia*; *Galinosoga porviflora*; *Musa paradisiaca*; *Chrysopogan fulvus*; *Ficus nemoralis*; *Eulaliopsisbinata* and *Boehmeria rugulosa.* Badri cow milk has a nutraceutical value; it could be due to the reason that they eat various types of grasses and medicinal plants present in the field sites, few are shown in the Figure 1.

Collection of Sample:

The milk samples were collected in a sterile bottle, carried out in coolant packs to the laboratory, and preserved at -20℃ for further investigation. The parameters were estimated, i.e., Crude Protein, Fat, Total solid, Solid not fat, and Ash. On-site parameters of milk pH, temperature, and water, were measured using pH strips (Loba Chemie), thermometer, and Lactometer (Quevene's); other parameters were performed in the laboratory using standard protocols. Crude Protein was analyzed by using the Kjeldhal method (A.O.A.C., 2000), the presence of fat content in milk by Gerber centrifuge method (F.A.O., 2003), Total Solid was recorded in oven-dried samples and ash by muffle furnace and Solid Not Fat was

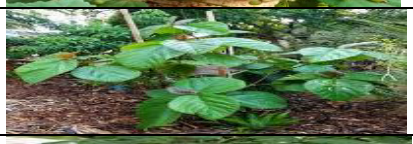
S. No.	Botanical Name	Common name	Plant Image
1	*Grewia optiva*	Bhimul	
2	*Ficus roxburghii*	Timil	
3	*Celtis austradis*	Khadak	
4	*Quercus leucotrichophora*	Baaj	
5	*Bauhinia variegata*	Koiral	
6	*Quercus semecarpifolia*	Kharsu	
7	*Galinosoga porviflora*	Marchi	
8	*Musa paradisiaca*	Banana leaves	
9	*Chrysopogan fulvus*	Godia	
10	*Ficus nemoralis*	Dudhila	
11	*Eulaliopsisbinata*	Babila grass	
12	*Boehmeria rugulosa*	Gheti	

Fig. 1: Common fodder species fed to Badri cow at study site Babiyar, Nainital.

determined by using the formula: Milk Solid Not Fat% = Total solids -Fat%.

Results and Discussion

Based on the field and laboratory investigations, Badri cow milk has an ideal pH, i.e., 6.8; Temperature 25.8 ˚C; Ash 0.70% and Crude Protein 3.48%. Total solid and solid not fat content is higher than the ideal range, i.e., 16.91% and 8.61%, respectively. Solid-not-fat consists of all solids other than fat. A higher range of Solid-not-fat and total solid content provide an excellent flavor and nutritional value to consumers, which is also suitable for the manufacturers of milk products. The Badri Cattle milk also has a higher fat content, i.e., 8.3%, which reduces the risk of Type 2 diabetes, blood pressure, and heart strokes.

During the present investigation, it was observed that the pH range of Indigenous cattle milk was 6.8 to 7.9, the Exotic cattle was 6.2- 6.6, and the Marketed milk ranged was 6.5-6.7 (Table 1). The maximum pH range was found in Indigenous Cattle (Gir cow), which is 7.9, and the minimum range is 6.8 in both the cattle breed (Badri cow and Ladakhi cow). The maximum range of Exotic Cattle pH was 6.6 (Jersey cow), and the minimum range was found in the Exotic cattle breed (Brown Swiss) 6.2. The maximum pH of 6.7 was found in marketed milk (Amul and Mother Dairy), and the minimum was in Aachal Dairy (6.5).

In Indigenous cattle milk, the temperature of fresh milk at release was recorded between 25℃-39℃; In Exotic cattle, it varies from 34℃- 38℃ (Table 1), and the Temperature of Marketed milk was 27℃ as kept in ambient temperature. The maximum milk Temperature was present in Indigenous Cattle (Gir Cow), i.e., 39℃, and the minimum milk temperature was found in Badri Cattle at 25.8℃. The maximum milk Temperature in Exotic Cattle (Jersey cow) was 38.9℃, and the minimum was found in Brown Swiss (34℃).

In Indigenous cattle milk, 12-16% of Total solids are present. In Exotic cattle, it ranges from 12-14%; in Marketed milk, 18.8% of total solids are present. The maximum range of Total solids in Indigenous Cattle (Badri cow) is 16.92%, and the minimum was found in Gir cow, i.e., 12.0% (Table 1). The maximum range of Total solids in Exotic Cattle (Jersey cow) is 14.6%, and the minimum range was found in Holstein – Friesian cow, i.e., 12.55%.

The Solid not fat value of the Indigenous cattle milk range was 8.5-8.6% (Table 1), The Exotic cattle milk range was 4-5%, and the value of Marketed milk was 8.5%. The maximum range of Solid not fat in Indigenous cattle is 8.61% (Badri cow), and the minimum range is 8.5% (Gir cow). The maximum range of Solid not fat in Exotic Cattel is 9.28% (Brown Swiss), and the minimum range is 8.38% (Holstein – Friesian cow).

The milk of Indigenous cattle contains 3-8% of fat, Exotic cattle milk has 4-5% of fat, and in locally Marketed milk 3-4 % of fat is present (Table 1). The Indigenous Cattle (Badri cow) milk has the full-fat content, i.e., 8.3%, and the minimum was found in Ladakhi cow (3.7%). In Exotic Cattle (jersey cow), milk has the full-fat content, i.e., 5.1%, and the minimum found in Holstein – Friesian cow was 3.83%. The full-fat content in marketed milk was present in (Aachal Dairy) 4.5%, and the minimum was in (Aachal Dairy) 3.5%.

The Ash content present in Indigenous cattle (Badri Cattle) milk was 0.70%, and in the Exotic cattle milk was 0.6-0.7% (Table 1). The maximum range of Ash in Exotic Cattel (Brown Swiss) is 0.78%, and the minimum range in Jersey cow is 0.67%.

Indigenous cattle milk has 3.2-3.5 % of Crude Protein (Table 1), Exotic cattle milk has 3.3-3.7%, and Marketed milk has 3.1-3.2%. The maximum range of crude protein in Exotic Cattle (Ladakhi cow) is 3.7%, and the minimum in Brown Swiss, i.e., 3.5%. In marketed milk, the maximum crude Protein present in Amul Dairy was 3.2%, and the

Table 1: Composition of Badri cow milk with exotic cattles and marketed milk

S. No.	Parameters%	Indigenous			Exotic Cow			Marketed milk		
		Badri cow	Gir Cow	Ladakhi Cow	Jersey cow	Holstein – Friesian	Brown Swiss	Aanchal Dairy	Amul Dairy	Mother dairy
1	pH	6.8	7.9	6.8	6.6	6.5	6.2	6.5	6.7	6.7
2	Temperature	25.8℃	39℃	34℃	38.9℃	38℃	34℃	27℃	DNA	DNA
3	Total solids (%)	16.91	12.0	DNA	14.6	12.55	12.64	18.8	DNA	DNA
4	Solid Not Fat (%)	8.61	8.5	DNA	9.5	8.38	9.28	8.5	8.5	8.5
5	Fat (%)	8.3	4.4	3.7	5.1	3.83	4.1	4.5	3.5	4.0
6	Ash (%)	0.70	DNA	0.7	0.67	0.75	0.78	DNA	DNA	DNA
7	Crude Protein(%)	3.48	3.2	3.5	3.7	3.34	3.5	3.1	3.2	3.1

Table 2: Correlation between different parameters of Badri cow milk

	Total Solid	Fat	SNF	Ash	Crude Protein	Acidity	Temp	pH	Water quality
Total Solid		0.879**	0.359	-0.083	0.632*	0.309	-0.427	0.249	-0.408
Fat	0.879**		-0.129	0.030	0.365	-0.003	-0.406	0.221	-0.753**
SNF	0.359	-0.129		-0.206	0.587	0.666*	-0.062	0.047	-0.624*
Ash	-0.083	0.030	-0.206		-0.325	0.191	0.515	-0.358	-0.094
Crude Protein	0.632*	0.365	0.587	-0.325		0.392	-0.652*	0.328	0.202
Acidity	0.309	-0.003	0.666*	0.191	0. 392		0.181	-0.247	0.469
Temperature	-0.427	-0.406	-0.062	0.515	-0.652*	0.181		-0.732*	0.106
pH	0.249	0.221	0.047	-0.358	0.328	-0.247	-0.732*		-0.023
Water quality	-0.408	-0.753**	-0.624*	-0.094	0.202	0.469	0.106	-0.023	

**Correlation is significant at the 0.01 level (2- tailed), *Correlation is significant at the 0.05 level (2-tailed)

minimum was present in Aanchal and Mother Dairy, i.e., 3.1%.

The correlation between the milk parameters is explained in Table 2. The total solids of milk are positively correlated with fat 0.879** and crude Protein 0.632* with significant levels of 0.01 and 0.05. When SNF is combined with milk fat, it is called total solids. According to the International dairy food Association, the solids portion of milk contains approximately 3.7% fat. Fat is a major component of milk and contributes to its total solids content. Milk fat is composed of triglycerides, which are energy-rich molecules. As the fat content of milk increases, the proportion of solid matter within the milk also increases, resulting in a higher total solids content. Crude Protein refers to the total protein content in milk, including casein and whey proteins (Kuzdzal-Savoie *et al.*, 1980; Davies *et al.*, 1983; Jenness, 1985). Protein is another significant component of milk, contributing to its nutritional value and total solids content. The proteins in milk are responsible for various functions, providing amino acids for growth and repair (Clark *et al*., 1978, Mepham, 1982). An increase in the protein content of milk leads to a higher proportion of solid matter, thus increasing the total solids content. The positive correlation between total solids, fat, and crude Protein can be attributed to the physiological processes involved in milk production. The synthesis and secretion of milk components, including fat and Protein, are closely regulated. When the cow is in good health, well-nourished, and adequately managed, it produces milk with higher levels of fat and Protein, which consequently increases the total solids content (Linn, 1988).

Fat Content is negatively correlated with water quantity -753** at a level of 0.01 (Welch *et al.*, 1997), explaining the relationship between fat content and water quantity in milk. According to Welch, milk is an oil-in-water emulsion, with fat globules dispersed within the aqueous phase of milk. The fat globules are hydrophobic and tend to repel water. As a result, an increase in the fat content of milk leads to a displacement of water.

This displacement results in a negative correlation between fat content and water quantity in milk. When milk is diluted with water, the fat content becomes proportionally lower because the fat is distributed in a larger volume of liquid. This dilution effect decreases the fat-to-water ratio, lowering fat content (Richmond, 2016).

Solid not fat is positively correlated with acidity 0.666* and negatively correlated with water quantity 0.624* at 0.05. SNF refers to the non-fat components of milk, which includes proteins, lactose (milk sugar), minerals, and vitamins. SNF represents the solid matter present in milk, excluding the fat content. As the SNF content increases, the proportion of solid matter in milk increases. Acidity in milk is primarily due to lactic acid, which is formed by lactose fermentation by lactic acid bacteria. The acidity level of milk is often measured as the pH or titratable acidity (Mehta, 2015). Higher levels of SNF in milk are associated with increased production of lactic acid by bacteria, resulting in higher acidity levels. The positive correlation between SNF content and acidity can be attributed to the relationship between the solid components of milk and lactic acid production. As the SNF content increases, there is greater availability of substrates (such as lactose) for bacteria to ferment, leading to higher lactic acid production and increased acidity. Water is the primary component of milk, and its quantity in milk is inversely related to the SNF content. As the SNF content increases, the proportion of water decreases in the overall composition of milk (Robert, 1987).

Crude Protein is negatively correlated with temperature -0.652*, and temperature is negatively correlated with pH -0.732* at the level of 0.05. Maciej *et al.* (2002) explained the effects of temperature on milk crude Protein. It has been explained that increasing the milk temperature can lead to a decrease in crude protein content. This decrease in protein content is attributed to various factors, including protein denaturation and aggregation. The protein content of milk, including crude Protein, is primarily influenced by factors such as animal genetics, diet, and lactation stage, rather than temperature alone. While temperature can impact certain milk quality and processing aspects, such as protein denaturation or bacterial activity, the direct correlation between crude protein content and temperature is not well-documented.

Farkye (2008) and Sharma *et al. (*1993) explains the correlation between temperature and pH. He explained that the temperature of milk increases as the pH decreases. The decrease in pH with increasing temperature can be attributed to several factors. One of the main factors is the increase in the activity of lactic acid bacteria, which produces lactic acid as a byproduct of lactose fermentation. As the temperature rises, the rate of bacterial metabolism and lactic acid production increases resulting in a decrease in pH.

Conclusion

The present study revealed that Badri cow milk exhibited higher levels of essential nutrients, such as proteins, vitamins, and minerals, compared to exotic cow milk and packaged milk. These elevated nutrient levels can be attributed to the breed's genetic makeup, favorable environmental conditions, and grazing practices specific to the Nainital region. The comparison between Badri and exotic cow milk demonstrated the distinct advantages of consuming milk from indigenous breeds. Supporting local dairy farmers who rear Badri cows promotes the preservation of indigenous breeds and ensures the consumption of nutrient-rich milk that aligns with a balanced and wholesome diet. Future research could decipher deeper into the specific components responsible for the nutritional superiority of Badri cow milk, as well as explore its potential benefits for specific health conditions. Additionally, conducting sensory evaluations to assess Badri cow milk's taste, texture, and overall sensory experience could provide further insights into its appeal to consumers. Choosing Badri cow milk

supports local farmers and offers consumers a healthier and more nutrient-rich option for incorporating dairy into their diets.

Acknowledgements

The authors are thankful to the administration of the Department of Zoology for providing the necessary support.

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