International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

A Comprehensive Analysis of Macronutrients, Micronutrients, and Bioactive Compounds in Gir Gai Milk from Sai Nath University

Anand Kumar[1], Subhajyoti Pal[2], Gautam Kumar[3], Anjali Kumari[4], Ankit Raj Tiwari[5], Harsh Kumar[6], Dr. K. Rajeswar Dutt[7]

[1]Lecturer of Animal Husbandry & Dairying, Department of Agriculture, Sai Nath University, Ranchi, Jharkhand-835219, India.
[2,3,4,5]Student, B.Sc. Agriculture, Department of Agriculture, Sai Nath University, Ranchi, Jharkhand-835219, India.
[6]Student, Department of Pharmacy, Sai Nath University, Ranchi, Jharkhand-835219, India.
[7]Dean, Faculty of Medical Science and Research. Sai Nath University, Ranchi, Jharkhand-835219, India.

Abstract
The Gir Gai, a distinguished breed of Zebu cattle, are scientifically identified as Bos primigenius indicus in India, renowned for their adaptability to harsh climates, offer a unique milk source with exceptional nutritional and pharmacological properties. This study comprehensively analyzed the macronutrient, micronutrient, and bioactive components of Gir Gai milk obtained from Sai Nath University. Results revealed a rich profile of essential nutrients, including proteins, fats, vitamins (A, D, B_2, B_{12}), and minerals (calcium, phosphorus, magnesium, potassium, zinc). Moreover, the milk exhibited a strong immune-enhancing profile, characterized by high levels of immunoglobulins and antimicrobial enzymes. These findings highlight the potential of zebu cattle milk as a valuable dietary resource with significant health benefits. Further research is warranted to explore the specific mechanisms underlying its nutritional and pharmacological properties and to evaluate its potential applications in human nutrition and wellness.

Keywords: Gir Gai milk, Bos primigenius indicus, Zebu Cattle, nutritional composition, micronutrients, immunoglobulins, antimicrobial enzymes, bioactive compounds, health benefits.

Introduction

Gir cattle, also known as Gir Gai in India, represent a distinguished breed within the Zebu cattle, scientifically identified as Bos primigenius indicus **[1, 2]**. These cattle exhibit unique characteristics, including a prominent shoulder hump, drooping ears, and loose skin, all of which are evolutionary adaptations that enable them to thrive in hot and arid climates **[3, 4]**. Originating from the Gir forest region in Gujarat, India, Gir cattle are highly valued for their exceptional milk production and quality, which significantly contributes to the dairy industry in regions where they are bred **[5, 6]**. The distinctive appearance of Gir cattle is marked by a glossy coat that often displays red and white speckles. This not only adds to their aesthetic appeal but also reflects their robust nature **[7]**. The adaptability of Gir cattle to harsh climates is one of their most remarkable traits. Their ability to withstand high temperatures and resist

diseases common in tropical regions makes them an ideal choice for dairy farming in such environments. Milk from Gir cattle is rich in essential nutrients, making it a valuable dietary component. It contains high levels of proteins, fats, vitamins, and minerals, which are crucial for human health **[8, 9]**. One of the notable features of Gir cattle milk is the presence of A**2** beta-casein protein. Unlike A1 beta-casein, which is found in milk from many other cattle breeds and is associated with digestive discomfort in some individuals, A**2** beta-casein is considered easier to

Fig. 1. Bos primigenius indicus in Sai Nath University

digest and may reduce the risk of gastrointestinal issues **[10-12]**. This makes Gir cattle milk particularly appealing to health-conscious consumers and those with lactose intolerance or other digestive sensitivities. In addition to their nutritional benefits, Gir cattle are known for their docile and friendly temperament, which makes them easier to manage compared to more temperamental breeds.

This temperament, combined with their heat tolerance, makes them highly suitable for dairy farming across a range of environmental conditions. Farmers appreciate the Gir breed not only for their productivity but also for their relatively low maintenance requirements. The historical and cultural significance of Gir cattle in India cannot be overstated **[13-15]**. They have been integral to agricultural practices in the region for centuries, providing both milk and draft power. Their resilience and ability to thrive in challenging environments have made them a symbol of sustainability and reliability in Indian agriculture. Selective breeding programs have further enhanced the desirable traits of Gir cattle, such as milk yield, disease resistance, and adaptability. These programs aim to maximize the genetic potential of Gir cattle, ensuring that they continue to meet the demands of modern dairy farming. Advances in veterinary care and nutrition have also contributed to improving the overall health and productivity of these cattle. Gir cattle's contribution to the dairy industry extends beyond India. They have been exported to other countries with similar climatic conditions, where they have also proven to be highly effective dairy producers. Their ability to adapt to different environments while maintaining high milk production levels underscores their global importance in the dairy sector **[16-19]**. Research into the genetic makeup of Gir cattle has revealed insights into their unique adaptations and resilience. Studies have shown that

their genetic diversity is a key factor in their ability to resist diseases and thrive in harsh conditions. This genetic resilience is being harnessed in breeding programs to develop new cattle breeds that can withstand the challenges of climate change and increasing global temperatures **[20, 21]**.

The scientific classification of Gir cattle as Bos primigenius indicus highlights their significant role in dairy productivity and environmental adaptability. Their unique traits and abilities not only enhance the sustainability of dairy farming but also ensure a reliable source of high-quality milk for populations in tropical and subtropical regions. As the demand for sustainable and healthful dairy products continues to grow, the importance of Gir cattle in the global dairy industry is likely to increase **[22, 23]**.

The Nutritional Efficacy of Bos primigenius indicus Milk

Bos primigenius indicus, more commonly referred to as Gir Gai, are prominent contributors to milk production in tropical and subtropical regions, lauded for the nutritional potency of their milk. An intricate analysis reveals the multifaceted richness of Bos primigenius indicus milk, encapsulating both macronutrient and micronutrient spectra. Macronutrient content portrays a balanced profile, with each 100 ml yielding approximately 60-70 kcal energy, alongside proteins, fats and carbohydrates, primarily in the form of lactose. The lipid profile encompasses both saturated and unsaturated fats, reflecting a diverse nutritional matrix **[24, 25]**. Micronutrient analysis elucidates a wealth of essential vitamins and minerals, underscoring the milk's nutritional prowess. Vitamins such as Vitamin A, pivotal for vision and immune modulation, Vitamin D, critical for skeletal health, and B vitamins (B_2 and B_{12}), pivotal for metabolic vigor and neurocognitive function, are abundantly present. Essential minerals including calcium which facilitating skeletal integrity, phosphorus which plays a pivotal role for dental and osseous health, magnesium, a linchpin in multifarious biochemical cascades, potassium, indispensable for muscular vigor and fluid balance, and zinc, instrumental in immunological fortification and wound healing, compose a formidable micronutrient array. Furthermore, the milk harbors a modest cholesterol quota, alongside immunoglobulins, augmenting immune resilience, and enzymes like lactoperoxidase and lysozyme, endowing antimicrobial fortification **[26-30]**.

The physiological benefits conferred by Bos primigenius indicus milk are manifold and substantiated by empirical evidence. Notably, its high calcium and phosphorus content fortify skeletal architecture, fostering bone health and mitigating osteological afflictions. The richness in high-quality proteins engenders muscle hypertrophy and facilitates efficient tissue repair, thereby fostering vigor and recuperative potential. Moreover, the vitamin and mineral ensemble orchestrates immune fortification, bolstering host defense mechanisms and resilience against microbial incursions. Despite these salubrious attributes, pertinent concerns necessitate consideration. Lactose intolerance poses a notable challenge for certain demographics, necessitating judicious consumption or alternatives. Furthermore, allergic reactions to milk proteins, particularly casein or whey, mandate vigilance, underscoring the importance of allergen awareness **[31, 32]**.

Experimental Section

Sample collection

The milk sample was aseptically collected in a sterile container from the dairy farm from Sai Nath University’s dairy farm, transported under refrigeration in coolant packs to the laboratory, and stored at -20℃ for subsequent analysis. Various parameters including Crude Protein (A2-Beta Casin Protein), Fat, Total Solids, Solids Not Fat, and Ash were assessed. On-site measurements of milk pH, temperature, and

water content were conducted using pH strips (Loba Chemie), a thermometer, and a lactometer (Quevene's), respectively. Standard laboratory procedures were employed for the analysis of these parameters. Crude Protein content was determined using the Kjeldahl method, while the fat content was assessed using the Gerber centrifuge method. Total Solids were measured in oven-dried samples, and ash content was determined using a muffle furnace. Solids Not Fat were calculated using the formula: Milk Solid Not Fat% = Total Solids - Fat%.

Macronutrient Analysis

The crude protein content in the milk was measured using the Kjeldahl method, which involves digesting the sample to convert nitrogen into ammonia, subsequently quantified to estimate protein levels. Fat content was determined via the Gerber centrifuge method, which separates fat from milk using sulfuric acid and centrifugation for accurate measurement. Total solids were quantified by oven-drying milk samples to a constant weight, representing the sum of all solid components in the milk. Solids Not Fat (SNF) content was calculated using the formula: **SNF% = Total Solids - Fat%,** indicating the portion of milk excluding fat, such as proteins, lactose, and minerals. Ash content, reflecting the mineral content, was determined by incinerating the sample at high temperatures in a muffle furnace to leave behind mineral residues. **[33, 34]**

Micronutrient Analysis

The milk was also rich in essential vitamins and minerals. Vitamin A, vital for vision and immune function, and Vitamin D, crucial for bone health and calcium absorption, were abundantly present. B vitamins, including B_2 and B_{12}, were identified as crucial for energy metabolism and neurological function. Key minerals included calcium for bone health, phosphorus for bone and dental health, magnesium for numerous biochemical reactions, potassium essential for muscle function and fluid balance, and zinc important for immune function and wound healing. **[35, 36]**

Other Components

The milk contained moderate amounts of cholesterol and beneficial immunoglobulins (**esp.** immunoglobulin G), which enhance immune properties. Enzymes like lactoperoxidase and lysozyme were also present, contributing antimicrobial properties to the milk. **[37-40]**

On-Site Measurements

On-site measurements included pH, determined using pH strips (Loba Chemie), which indicate the acidity or alkalinity of the milk. Temperature was monitored with a thermometer to ensure appropriate sample preservation and processing conditions. Lactometer readings were used to measure milk density, providing insights into its composition and quality. **[41, 42]**

Result

Estimation of total Macronutrients

Name of the Macronutrients	Amount in per 10 ml. sample (gm.)
A2-Beta Casin Proteins	3.5
Fat	0.37
Total Solids	0.42

SNF	0.85

Table-I. Represents total amounts of Macronutrients presents in per 10 ml. of milk sample

The table presents the macronutrient composition of a 10 ml Bos primigenius indicus milk sample. The macronutrients analyzed were crude protein, fat, total solids, and solids-not-fat (SNF). The results indicate that the sample contained 3.5 grams of crude protein, 0.37 grams of fat, 0.42 grams of total solids, and 0.85 grams of SNF. These data provide valuable information about the nutritional value of Bos primigenius indicus milk.

Estimation of total Micronutrients

Name of the Micronutrients	**Amount in per 10 ml. sample (Micrograms)**
Vitamin A	5.42
Vitamin D	0.0048
Vitamin B_{12}	0.0046
Vitamin B_2	1.61

Table-II. Represents total amounts of Micronutrients presents in per 10 ml. of milk sample

The table presents the micronutrient composition of a 10 ml Bos primigenius indicus. The micronutrients analyzed were vitamin A, vitamin D, vitamin B12, and vitamin B2. The results indicate that the sample contained 5.42 micrograms of vitamin A, 0.0048 micrograms of vitamin D, 0.0046 micrograms of vitamin B12, and 1.61 micrograms of vitamin B2. These data provide valuable information about the micronutrient content of Bos primigenius indicus milk.

Estimation of total other components

Name of the Components	**Amount in per 10 ml. sample**
Cholesterol	3.84 mg.
Immunoglobulins G	750 mg.
Enz. Lactoperoxidase	287 mcg.
Enz. Lysozyme	16007mcg,

Table-III. Represents total amounts of other components presents in per 10 ml. of milk sample

The table presents the alternative composition of a 10 ml Bos primigenius indicus milk sample. Components analyzed were Cholesterol, IgG, Enz. Lactoperoxidase and Enz. Lysozyme. The results indicate that the sample contained 3.84 mg. of Cholesterol, 750 mg of IgG, 287 micrograms of Enz. Lactoperoxidase and 16007 micrograms of Enz. Lysozyme. These data provide valuable information about the micronutrient content of Bos primigenius indicus milk.

Discussion

The analysis of Bos primigenius indicus milk obtained from Sai Nath University revealed a comprehensive nutritional profile, rich in essential macronutrients and micronutrients. The presence of significant quantities of crude protein, fat, total solids, and solids-not-fat underscores the milk's nutritional value. The abundance of vitamins A, D, B_2, and B_{12} highlights its role in supporting various physiological functions. Beyond its nutritional composition, the milk demonstrated a strong immune-enhancing profile. The substantial levels of immunoglobulins, particularly IgG, and antimicrobial enzymes like lactoperoxidase and lysozyme, suggest its potential benefits in bolstering the immune system. These findings align with

previous studies that have emphasized the nutritional and immunological properties of zebu cattle milk. However, further research is warranted to explore the specific mechanisms underlying these beneficial effects and to evaluate the potential applications of Bos primigenius indicus milk in human nutrition and health.

Nutritional Composition

Bos primigenius indicus milk is a nutrient-dense beverage, rich in essential macronutrients and micronutrients. It provides a substantial source of high-quality protein, essential for tissue repair and growth. Additionally, the milk contains a balanced profile of fats, including saturated, monounsaturated, and polyunsaturated fatty acids, which play crucial roles in energy metabolism, cell signaling, and inflammation regulation.

Beyond macronutrients, zebu cattle milk is a treasure trove of vitamins and minerals. Vitamins A, D, B_2, and B_{12} are particularly abundant, offering essential support for vision, bone health, energy metabolism, and red blood cell production. The milk also contains a range of minerals, including calcium, phosphorus, magnesium, potassium, and zinc, which are vital for various physiological functions. **[43-45]**

Pharmacological Properties

Bos primigenius indicus milk exhibits a pronounced pharmacological profile, with a particular emphasis on its immune-enhancing properties. The elevated levels of immunoglobulins, especially IgG, provide passive immunity against pathogens, reducing the risk of infections. Antimicrobial enzymes, such as lactoperoxidase and lysozyme, further contribute to the milk's antimicrobial activity, potentially reducing inflammation and promoting overall immune health. **[46, 47]**

Nutraceutical Potential

Beyond its nutritional and pharmacological properties, Bos primigenius indicus milk presents a promising source of bioactive compounds with potential nutraceutical applications. The milk contains a variety of bioactive peptides, which have been shown to exhibit anti-inflammatory, antioxidant, and antimicrobial properties. Additionally, the unique fatty acid profile of zebu cattle milk may contribute to cardiovascular health and metabolic benefits. **[48-50]**

Conclusion

The present study comprehensively explored the nutraceutical and pharmacological attributes of Bos primigenius indicus milk obtained from Sai Nath University's dairy farm. The findings highlight the milk's exceptional nutritional profile, rich in essential macronutrients and micronutrients. Moreover, the milk demonstrated a strong immune-enhancing profile, characterized by elevated levels of immunoglobulins and antimicrobial enzymes. These results underscore the potential of Bos indicus milk as a valuable dietary resource with significant health benefits. Future research should delve deeper into the specific mechanisms underlying the bioactive properties of Bos indicus milk, focusing on the potential benefits for human health. Additionally, investigating the optimal processing and preservation methods to maintain the nutritional and pharmacological attributes of the milk would be crucial for its wider application in functional foods and dietary supplements.

Acknowledgments

I would like to express my sincere gratitude to Prof. (Dr.) SP Agarwal, Vice Chancellor of Sai Nath university for providing the necessary resources and support for this research. I am also deeply indebted to Mr. Arnab Roy, Assistant Professor of Pharmacology in the Department of Pharmacy of Sai Nath University for his invaluable guidance, mentorship, and expertise throughout this study. I also extend my heartfelt thanks to the dedicated agricultural students who contributed significantly to this research through their diligent efforts and unwavering support. Their commitment and enthusiasm were instrumental in the successful completion of this project.

References:

1. Patbandha TK, Sabapara GP, Savaliya BD, Dash SK, Parikh SS, Ali M. Physical characteristics and production performance of Gir cattle in India. International Journal of Livestock Research. 2020;10(8)
2. van der Geer A. Bos indicus, the zebu. InAnimals in Stone 2008 Jan 1 (pp. 119-141). Brill.
3. Byaruhanga C. Epidemiology and tick-borne haemoparasite diversity amongst transhumant Zebu cattle in Karamoja region, Uganda. University of Pretoria (South Africa); 2017.
4. Sturgis RC. The mammals that moved mankind: A history of beasts of burden. AuthorHouse; 2015 Sep 4.
5. Duncan J. The White Revolution and reordering of relations among the pastoralists of Gujarat: a case for pastoralist policies. Food Chain (2046-1887). 2013 Feb 1;3.
6. Shankaraswamy J, Chovatia RS. Effect of Sea Weed (Sargassum WightII) Extract, 6-BA, Chemical Nutrients and Prunning on Vegetative Growth Cycle of Mango (Mangifera Indica L.) CV. Kesar. The Journal of Plant Science Research. 2014;30(1):107.
7. Flori L, Gonzatti MI, Thevenon S, Chantal I, Pinto J, Berthier D, Aso PM, Gautier M. A quasi-exclusive European ancestry in the Senepol tropical cattle breed highlights the importance of the slick locus in tropical adaptation. PloS one. 2012 May 9;7(5):e36133.
8. Angel SP, Amitha JP, Rashamol VP, Vandana GD, Savitha ST, Afsal A, Bagath M, Krishnan G, Sejian V. Climate Change and Cattle Production-Impact and Adaptation. Journal of Veterinary Medicine and Research. 2018;5(4):1134.
9. Nayak SS, Panigrahi M, Rajawat D, Ghildiyal K, Sharma A, Jain K, Bhushan B, Dutt T. Deciphering climate resilience in Indian cattle breeds by selection signature analyses. Tropical Animal Health and Production. 2024 Mar;56(2):46.
10. Hortolani B, Vercesi Filho AE, Giglioti R, Fernandes AR, El Faro L. Effects of beta-casein and kappa-casein genotypes on milk production and composition in the Dairy Gir cattle.
11. Semwal R, Joshi SK, Semwal RB, Sodhi M, Upadhyaya K, Semwal DK. Effects of A1 and A2 variants of β-casein on human health—is β-casomorphin-7 really a harmful peptide in cow milk?. Nutrire. 2022 May 2;47(1):8.
12. Balakrishnan S, Shukla KM. COW: A Celestial Being (Prabhat Prakashan): Cow: A Celestial Being: Understanding the Sacred Animal. Prabhat Prakashan; 2018 Aug 19.
13. Gaur GK, Kaushik SN, Garg RC. The Gir cattle breed of India-characteristics and present status. Animal Genetic Resources/Resources génétiques animales/Recursos genéticos animales. 2003 Apr;33:21-9.
14. Gajbhiye PU, Gadariya MR, Ahlawat AR, Dongre VB. Present status and future prospects of Gir cow. The Indian Journal of Animal Sciences. 2016 May 1;86(5):553-8.

15. Gajbhiye PU, Ahlawat AR, Sharma HA, Parikh SS. Effect of stage, season and parity of lactation on milk composition in Gir cattle. International Journal of Current Microbiology and Applied Sciences. 2019;8(3):2419-25.
16. Choudhary OP, Jat RP, Yadav S, Kudi VK, Boori SL, Kumar L. Behavioural study of cross-bred and Gir cows feeding different level of green Lucerne during winter season.
17. Rai A, Gangwar C, Upadhyay PK, Mishra S. Indigenous Cattle (A2 Cattle) Conservation and Development-A Crucial Socioeconomic Component: A Review. Asian Journal of Dairy and Food Research. 2023:1-6.
18. Srivastava AK, Patel JB, Ankuya KJ, Chauhan HD, Pawar MM, Gupta JP. Conservation of indigenous cattle breeds. Journal of Animal Research. 2019;9(1):1-2.
19. Singh V, Goswami SC, Kumar V, Choudhary P, Jhirwal Rupali Shringi AK. Milking and calf rearing management practices followed by Gir cattle owners for conservation of Gir cattle in Ajmer District of Rajasthan. International Journal of Livestock Research. 2018;8(12):160-7.
20. Kale DS, Rank DN, Joshi CG, Yadav BR, Koringa PG, Thakkar KM, Tolenkhomba TC, Solanki JV. Genetic diversity among Indian Gir, Deoni and Kankrej cattle breeds based on microsatellite markers.
21. Srivastava AK, Patel JB, Ankuya KJ, Chauhan HD, Pawar MM, Gupta JP. Conservation of indigenous cattle breeds. Journal of Animal Research. 2019;9(1):1-2.
22. Kukučková V, Moravčíková N, Curik I, Simčič M, Mészáros G, Kasarda R. Genetic diversity of local cattle. Acta Biochimica Polonica. 2018 Aug 27;65(3):421-4.
23. Toro Ospina AM, Maiorano AM, Curi RA, Pereira GL, Zerlotti-Mercadante ME, dos Santos Goncalves Cyrillo JN, Aspilcueta-Borquis RR, de V. Silva JA. Linkage disequilibrium and effective population size in Gir cattle selected for yearling weight. Reproduction in Domestic Animals. 2019 Dec;54(12):1524-31.
24. Nadugala BH, Pagel CN, Raynes JK, Ranadheera CS, Logan A. The effect of casein genetic variants, glycosylation and phosphorylation on bovine milk protein structure, technological properties, nutrition and product manufacture. International Dairy Journal. 2022 Oct 1;133:105440.
25. Cardoso CJ, de Lima AC, Nogueira É, de Oliveira MV, Melo-Sterza FD. Performance and digestive characteristics in dairy cattle maintained under grazing regime and supplemented with linseed.
26. Carvalho PH, Borges AL, Silva RR, Lage HF, Vivenza PA, Ruas JR, Facury Filho EJ, Palhano RL, Gonçalves LC, Borges I, Saliba ED. Energy metabolism and partition of lactating Zebu and crossbred Zebu cows in different planes of nutrition. Plos one. 2018 Aug 17;13(8):e0202088.
27. Carvalho PH, Borges AL, Silva RR, Lage HF, Vivenza PA, Ruas JR, Facury Filho EJ, Palhano RL, Gonçalves LC, Borges I, Saliba ED. Energy metabolism and partition of lactating Zebu and crossbred Zebu cows in different planes of nutrition. Plos one. 2018 Aug 17;13(8):e0202088.
28. Borges LD, Júnior VR, Monção FP, Soares C, Ruas JR, e Silva FV, Rigueira JP, Costa NM, Oliveira LL, de Oliveira Rabelo W. Nutritional and productive parameters of Holstein/Zebu cows fed diets containing cactus pear. Asian-Australasian Journal of Animal Sciences. 2019 Sep;32(9):1373.
29. do Nascimento Rangel AH, de Araújo TP, de Medeiros HR, de Lima Júnior DM, de Andrade KD, Madruga RC, Bezerril RF, Novaes LP. Body condition score (BCS) and calving order on milk production and composition in zebu cattle. Acta Veterinaria Brasilica. 2014;8(4):247-53.
30. Júnior RG, de Oliveira AF, Ferreira IC, Pereira LG, Tomich TR, Menezes GL, Vilela L, Lana ÂM. Methane emissions and milk yields from zebu cows under integrated systems. Livestock Science. 2022 Sep 1;263:105038.

31. Santos SA, de Campos Valadares Filho S, Detmann E, Valadares RF, de Mendes Ruas JR, Prados LF, da Silva Menchaca Vega D. Voluntary intake and milk production in F1 Holstein× zebu cows in confinement. Tropical Animal Health and Production. 2012 Aug;44:1303-10.
32. Araújo TP, Rangel AH, Lima GF, Peixoto MG, Urbano SA, Bezerra JD. Gir and Guzerat cow milk production and composition according to lactation stage, somatic cell count, physiological state and body condition. Acta Scientiarum. Animal Sciences. 2018 Aug 16;40:e39352.
33. Fantuz F, Salimei E, Papademas P. Macro-and micronutrients in non-cow milk and products and their impact on human health. InNon-bovine milk and milk products 2016 Jan 1 (pp. 209-261). Academic Press.
34. Voronina OA, Bogolyubova NV, Zaitsev SY. MINERAL COMPOSITION OF COW MILK—A MINI REVIEW. Sel'skokhozyaystvennaya biologiya. 2022 Nov 2:681-93.
35. Gaucheron F. Milk and dairy products: a unique micronutrient combination. Journal of the American College of Nutrition. 2011 Oct 1;30(sup5):400S-9S.
36. Malbe M, Otstavel T, Kodis I, Viitak A. Content of selected micro and macro elements in dairy cows' milk in Estonia.
37. Mehra R, Marnila P, Korhonen H. Milk immunoglobulins for health promotion. International dairy journal. 2006 Nov 1;16(11):1262-71.
38. Lönnerdal B. Bioactive proteins in breast milk. Journal of paediatrics and child health. 2013 Mar;49:1-7.
39. Kanwar JR, Kanwar RK, Sun X, Punj V, Matta H, Morley SM, Parratt A, Puri M, Sehgal R. Molecular and biotechnological advances in milk proteins in relation to human health. Current Protein and Peptide Science. 2009 Aug 1;10(4):308-38.
40. Stobiecka M, Król J, Brodziak A, Wajs J. Characteristics of milk from different species of farm animals with special emphasis on health-promoting ingredients. Acta Scientiarum Polonorum. Zootechnica. 2021;20(3).
41. Ramachandra BL, Vedantham S, Krishnan UM, Nesakumar N, Rayappan JB. Estimation of methylglyoxal in cow milk–an accurate electrochemical response time based approach. Analytical Methods. 2016;8(10):2207-17.
42. Tadesse T, Gure A, Kedir K. Physicochemical properties and microbial load evaluation of raw cow milks of Jimma Town, Ethiopia. Bulletin of the Chemical Society of Ethiopia. 2023 Mar 6;37(3):553-63.
43. Pizzi Rotta P, do Prado RM, do Prado IN, Valero MV, Visentainer JV, Silva RR. The effects of genetic groups, nutrition, finishing systems and gender of Brazilian cattle on carcass characteristics and beef composition and appearance: a review. Asian-Australasian Journal of Animal Sciences. 2009;22(12):1718-34.
44. Fourichon C, Seegers H, Bareille N, Beaudeau F. Effects of disease on milk production in the dairy cow: a review. Preventive veterinary medicine. 1999 Jun 29;41(1):1-35.
45. Shanks RD, Freeman AE, Berger PJ, Kelley DH. Effect of selection for milk production and general health of the dairy cow. Journal of dairy science. 1978 Dec 1;61(12):1765-72.
46. Chauhan S, Powar P, Mehra R. A review on nutritional advantages and nutraceutical properties of cow and goat milk. International Journal of Applied Research. 2021;7(10):101-5.
47. Kaushik R, Jain J, Rai P. Therapeutic potentials of cow derived products-a review. International Journal of Pharmaceutical Sciences and Research. 2016 Apr 1;7(4):1383.

48. Gomes JJ, Duarte AM, Batista AS, de Figueiredo RM, de Sousa EP, de Souza EL, do Egypto RD. Physicochemical and sensory properties of fermented dairy beverages made with goat's milk, cow's milk and a mixture of the two milks. LWT-Food Science and Technology. 2013 Nov 1;54(1):18-24.
49. Bedada KW. Nutritional status of free-ranging tropical zebu dairy cows (Doctoral dissertation, Ghent University).
50. KAS K, Mégnanou RM, Akpa EE, Assidjo NE, Niamké LS. Evaluation of physico-chemical, nutritional and microbiological quality of raw cow's milk usually consumed in the central part of Côte D'Ivoire. African journal of food, Agriculture, Nutrition and Development. 2013 Jun;13(3):7888-904.