



Heterogeneity in Physio-Chemical Traits of Milk across Buffalo Breeds in Haryana

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Article History	Abstract
Received: 26 May 2023 Revised: 15 Sept 2023 Accepted: 01 Oct 2023	<p><i>This research paper presents a comparative analysis of the physio-chemical properties of milk from three different buffalo breeds in Haryana, namely Murrah, Nilli-Ravi, and Surti. The study aimed to evaluate various parameters including fat content, solid not fat (SNF), total solids, protein content, density, lactose content, titratable acidity, freezing point, pH, and specific gravity. A total of 60 buffaloes, 20 from each breed, were selected for the study, and milk samples were collected twice a day, in the morning and evening. The analysis revealed significant differences among the three buffalo breeds in terms of their milk composition. The Murrah breed exhibited the highest fat content (8.02), while the Nilli-Ravi had the lowest (8.14). For SnF values, Murrah shows highest values of 9.41 and Surti buffalo shows lowest 8.78. Similarly, variations were observed in other parameters across different breeds. These results can assist in breed selection for improved milk production, processing, and product development. Furthermore, the data obtained can serve as a valuable resource for dairy industry stakeholders, regulatory bodies, and researchers in the field of dairy science and technology. Future studies could explore the relationship between physio-chemical properties and milk yield, as well as investigating the impact of these variations on the processing and quality of dairy products.</i></p>
CC License CC-BY-NC-SA 4.0	Keywords: Buffalo, Physio-chemical analysis, milk, Murrah, Nilli-Ravi, Surti

1. Introduction

The physio-chemical properties of milk are vital, impacting its nutritional value, suitability for processing, and overall quality. Variations in these properties among dairy animals have substantial implications for the dairy industry, affecting farmers and consumers [1,2]. Understanding these differences among buffalo breeds - Murrah, Nilli-Ravi, and Surti - is crucial for optimizing milk production and product development in India's thriving dairy sector.

India's robust dairy industry highly values buffalo farming [3]. Farmers' choices in buffalo breed selection significantly affect milk composition and quality [4]. This comprehensive study delves into key parameters like fat content, solid not fat (SNF), total solids, proteins, density, lactose content, titratable acidity, freezing point, pH, and specific gravity across these distinctive buffalo breeds, recognized for their contributions to India's milk production [2,4].

Murrah, a prized indigenous breed, is celebrated for prolific milk yield and adaptability to various environments [5]. **Nilli-Ravi**, another indigenous breed, is valued for its rich milk solids content, particularly fat and milk proteins, and resilience to heat stress [6]. **Surti**, an indigenous breed, is esteemed for its robust nature and adaptability [7]. Milk samples were collected from 20 buffaloes of each breed, twice daily. The analysis unveils significant variations among these buffalo breeds [8]. These insights will aid in breed selection, milk processing, and product development in India's dairy sector [6,8].

This research aims to assess milk composition variations, discover breed-specific trends, and provide valuable data for dairy farming and processing. It also serves as a resource for researchers and stakeholders committed to enhancing milk quality and the dairy sector's contribution to India's economy [9]. Understanding the physio-chemical attributes empowers farmers' decisions on breed selection, feeding practices, and milk processing, providing consumers with quality dairy products aligned with

their preferences [10]. This research bridges knowledge gaps and forms the basis for future studies on buffalo milk composition's relationship with yield and environmental factors [10].

2. Materials And Methods

Selection of Buffalo Breed:

The selection of buffalo breeds for this research was based on the following criteria:

1. **Genetic Diversity:** The inclusion of buffalo breeds with diverse genetic backgrounds allows for a comprehensive analysis of milk properties [11].
2. **Regional Significance:** Buffalo breeds selected for this study are of particular relevance to the Haryana region, known for its dairy farming. [11,13]
3. **Indigenous Breeds:** The inclusion of indigenous buffalo breeds, such as Sahiwal and Tharparkar, highlights the importance of preserving local genetic resources [12].
4. **Cross-Breed Representation:** The presence of cross-bred buffaloes in the study ensures a broader understanding of milk composition, considering the potential impact of hybridization [14].
5. **Practical Applicability:** The selected buffalo breeds are widely utilized in the local dairy industry, making the findings of this study directly relevant and applicable to dairy farmers and stakeholders [14].
6. **Comparative Analysis:** By comparing multiple buffalo breeds, the research aims to identify similarities and differences in the physio-chemical properties of their milk, contributing to the existing body of comparative dairy research [15].

By considering these criteria for breed selection, the research aims to provide comprehensive insights into the physio-chemical properties of milk from various buffalo breeds in Haryana, contributing to the knowledge base of the local dairy industry and supporting evidence-based decision-making.

Sample Collection:

A total of 60 milk samples were collected, with 20 samples from each of the four selected buffaloes breeds:

Murrah, Nilli-Ravi and Surti. The total duration of the experiment was 60 days. The sampling process followed a structured approach to capture the variations in milk properties across the different breeds.

The sampling was conducted in three districts of Haryana: Sonapat, Panipat, and Karnal. These districts were chosen based on their significance in dairy farming and the availability of the selected buffalo breeds in the region [17]. By sampling buffaloes from multiple districts, we aimed to capture potential variations in milk properties that could arise from geographic and environmental factors.

The milk samples were collected twice a day, once in the morning and again in the evening [12,17]. This approach accounted for any potential diurnal variations in milk composition and ensured a comprehensive assessment of the physio-chemical properties throughout the day. By collecting samples at these specific times, we aimed to capture the natural fluctuations that may occur in milk composition due to factors such as feeding patterns, buffalo physiology, and milking intervals. The sample collection process adhered to strict hygiene standards and best practices to maintain the integrity of the samples [18]. Each sample was carefully collected using sterile containers and labelled with appropriate identifiers to ensure traceability and accurate record-keeping [18,19].

Furthermore, the selection of 20 buffaloes from each breed ensured a representative sample size, allowing for robust statistical analysis and reliable conclusions [20]. By including a sufficient number of samples from each breed, we aimed to account for individual variations within the breed and minimize any potential bias.

Sample Preparation:

To maintain the integrity of the samples and facilitate reliable measurements of physio-chemical properties, a standardized procedure was followed for sample preparation [19,20]. Upon collection, the milk samples were immediately transferred to a controlled laboratory environment to minimize any potential degradation or changes in composition [20]. The samples were stored at appropriate temperatures to maintain their freshness and prevent bacterial growth.

To ensure homogeneity and consistency, the milk samples underwent thorough mixing and agitation [21]. Gentle but thorough stirring or swirling of the samples was performed to distribute any fat globules

or solid particles uniformly. This step aimed to minimize any variations in the milk composition that may have occurred due to natural separation or settling during collection and transportation. To remove any extraneous matter or impurities, the samples were carefully filtered using sterile filter papers or similar filtration methods. This process helped eliminate particulate matter and ensured that the subsequent analysis focused solely on the milk's physio-chemical properties.

Sample Analysis:

The sample analysis for the physio-chemical properties of the milk samples was conducted at the esteemed National Dairy Research Institute in Karnal, Haryana. The institute's state-of-the-art facilities and expertise ensured accurate and reliable measurements of the various parameters. To assess the composition of the milk samples, key parameters such as fat content, protein content, lactose content, density, freezing point, solid not fat (SNF), and total solids were analyzed. The Milk Analyzer, specifically the Lacto Scan, was utilized for the analysis of fat, protein, lactose, density, freezing point, SNF, and total solids. This instrument employs advanced technology to provide precise and efficient measurements of these parameters.

The pH of the milk samples was determined using a digital pH meter, which offers high accuracy and sensitivity in measuring the acidity or alkalinity of the samples [17,21]. For the determination of specific gravity, the methodology prescribed in the BIS Handbook (IS: 1103-1965) was followed [21]. Titratable acidity, a measure of the acidity level in the milk, was determined as per the guidelines outlined in the BIS Handbook (IS 1479-1961) [25,26]. This analysis helps evaluate the milk's freshness and can indicate the presence of any undesirable changes or microbial activity.

The utilization of specialized equipment and adherence to standard methodologies ensures the accuracy and reliability of the sample analysis. The National Dairy Research Institute's expertise and commitment to quality contribute to the robustness of the results obtained for the physio-chemical properties of the milk samples. By employing these advanced analytical techniques and following established standards, the research aims to provide comprehensive insights into the physio-chemical characteristics of the milk from the selected buffalo breeds in Sonipat, Panipat, and Karnal districts of Haryana.

Parameters observed during experiment

Gross chemical compositions

- a) Fat
- b) Solid Not Fat (SNF)
- c) Total solids
- d) Protein
- e) Lactose
- f) Density

Physio-chemical properties

- a) Titratable acidity
- b) Freezing Point
- c) pH
- d) Specific Gravity

All samples were analysed by using Lacto scan at NDRI, Karnal whereas, for Fat, SNF, Acidity, pH and Specific Gravity samples were also analysed manually at NDRI, Karnal.

Data Analysis:

The collected data from the physio-chemical analysis of the milk samples were subjected to rigorous statistical analysis. To compare the data among the different buffalo breeds, various statistical tools were employed. Analysis of Variance (ANOVA) was utilized to evaluate the differences and similarities in the physio-chemical properties of the milk samples across the selected breeds. ANOVA helps determine if there are statistically significant variations between the groups being compared.

The average or mean values of the physio-chemical properties were calculated to obtain a representative measure of the central tendency for each parameter within each buffalo breed. This allowed for a clear understanding of the average composition of the milk samples from the different breeds.

In statistical analysis, it is crucial to establish the significance of the observed differences. In this study, a significance level of $P < 0.05$ was chosen, indicating that any differences observed between the breeds were considered statistically significant if the probability of such differences occurring by chance alone

was less than 5%. This threshold provides a reliable basis for determining the significance of the finding [22].

3. Results and Discussion

Gross Chemical Composition Analysis

Fat

Fat percentage content in the milk of Murrah, Nili Ravi and Surti breeds of buffalo in morning ranges 8.10, 7.18, 7.24 respectively, whereas in evening it ranges as 7.94, 7.10, 7.12 respectively. The high to low trend of fat percentages observed in the milk of these two breeds are as follows, Murrah having significantly ($P < 0.05$) more fat content than Surti and last is Nili Ravi in both morning and evening. The average percentages of total fat content were higher in Murrah (8.02) among the different breeds followed by Surti (7.18) and last is Nilli Ravi (7.14).

Time/Breed	Murrah	Nilli - Ravi	Surti
Morning	8.10 \pm 0.04	7.18 \pm 0.02	7.24 \pm 0.04
Evening	7.94 \pm 0.02	7.10 \pm 0.06	7.12 \pm 0.02
Total	8.02 \pm 0.03	7.14 \pm 0.04	7.18 \pm 0.03

Table 1

Variations of Fat (%) in Morning and Evening in different breeds of buffaloes.

This study is in agreement with Sodi *et al.* (2008), Ceballos *et al.* (2009) and Enb *et al.* (2009). They observed the average fat percentage 7.90 in buffaloes. The study was also carried on eighty samples of raw Buffalo milk from Guangxi, China for chemical compositional analysis and found fat content in milk of Murrah Buffalo as 7.32%. Mahmood and Usman (2010), Misra *et al.* (2008) reported that the comparative milk composition of various breeds of Buffalo having average fat content in milk of Nili Ravi, Bhadawari, Mehsana and Murrah Buffalo 6.17 \pm 0.20%, 7.43 \pm 0.26%, 6.4 \pm 60.17% and 7.53 \pm 0.19% respectively.

SNF

The study revealed that the morning to evening percentage of SNF content in Murrah, Nili Ravi, and Surti milk ranged from 9.51 to 9.32, 9.37 to 9.03, and 8.84 to 8.72, respectively. In both the morning and evening, the average SNF content percentage was significantly higher in Murrah, followed by Nili Ravi and Surti. Among the different breeds, Murrah had the highest average SNF content of 9.41, followed by Nili Ravi at 9.20 and Surti at 8.78. These findings are in agreement with previous studies by Rao and Ramamurthy (1973), Basu *et al.* (1962), and Juma and Alsafar (1970). Sindhu and Singhal (1988) reported a higher SNF content of 9.7% in buffalo milk, which is similar to the findings of Misra *et al.* (2008) related to Surti breed.

Additionally, the SNF content observed in Murrah Buffalo milk aligns with the results reported by Misra *et al.* (2008), which found an average SNF content of 9.00 \pm 0.07%. Sodi *et al.* (2008) reported an overall mean SNF percentage of 9.40 and demonstrated that non-genetic factors can affect the composition of Murrah Buffalo milk. On the contrary, Imran *et al.* (2008), Liang *et al.* (2013), Pandey *et al.* (1984), and Han *et al.* (2007) observed higher average values of raw Buffalo milk collected from different locations in China, with an SNF content of 10.85%. The SNF content observed in the present investigation in Murrah Buffalo milk was higher compared to the results reported by Ahmad *et al.* (2008).

Time/Breed	Murrah	Nilli - Ravi	Surti
Morning	9.51 \pm 0.06	9.37 \pm 0.02	8.84 \pm 0.04
Evening	9.32 \pm 0.02	9.03 \pm 0.04	8.72 \pm 0.02
Total	9.41 \pm 0.04	9.20 \pm 0.03	8.78 \pm 0.003

Table 2

Variations of SnF (%) in Morning and Evening in different breeds of buffaloes.

Total Solids

The study revealed that the morning to evening percentage of total solids content in Murrah, Nili Ravi, and Surti milk ranged from 18.27 to 17.75, 17.45 to 16.69, and 15.97 to 15.55, respectively. In both the morning and evening, the average total solids content was significantly higher in Murrah compared to Nili Ravi & Surti breed. Among the different breeds, Murrah had the highest average total solids content of 18.01, followed by Nili Ravi at 17.07 and Surti at 15.76.

Time/Breed	Murrah	Nilli - Ravi	Surti
Morning	18.27 ± 0.02	17.45 ± 0.05	15.97 ± 0.04
Evening	17.75 ± 0.04	16.69 ± 0.01	15.55 ± 0.04
Total	18.01 ± 0.006	17.07 ± 0.002	15.76 ± 0.003

Table 3

Variations of Total Solid (%) in Morning and Evening in different breeds of buffaloes.

These findings are in agreement with the results reported by Enb et al. (2009), Sodi et al. (2008), and Hanmante et al. (2003), which also observed similar total solids content in Murrah and Nili Ravi milk. However, the SNF content in the present investigation was on the lower side compared to the results reported by Misra et al. (2008), who reported mean total solids content in Nili Ravi Buffalo milk and Murrah Buffalo milk as 14.96±0.21% and 16.53±0.20%, respectively.

The findings of this study also align with the data reported by Soliman (2005), who observed that the chemical compositions and mineral contents in human milk were lower than Buffalo milk in Egypt, with an average total solids content of Buffalo milk reported as 17.65±0.10%. Han et al. (2007) analyzed 80 raw Buffalo milk samples collected from different locations in China and found a total solids content of 18.44%. The total solids content of milk from multi-crossbreed Buffaloes was higher than that of river Buffaloes but lower than that of crossbreed F¹ and F² Buffaloes. Imran et al. (2008) reported a significant effect on total solids content in milk from different breeds of Buffaloes in various areas of Pakistan, with a mean total solids content of 17.28%.

Proteins

It revealed that the protein content in the milk of Murrah, Nili Ravi, and Surti breeds in the morning is 3.42, 3.38, and 3.93, respectively, while in the evening it ranged as 3.38, 3.32, and 3.85, respectively. The average protein content in both the morning and evening milk of Nili Ravi and Murrah breeds was almost similar, showing non-significant differences ($P>0.05$). Similarly, the average differences in total protein content were also non-significant ($P>0.05$) in Nili Ravi (3.32) and Murrah (3.38) when considering the cumulative morning and evening averages. As for the Surti breed, the protein content was higher, with an average of 3.93 in the morning and 3.85 in the evening with cumulative value of 3.89.

Time/Breed	Murrah	Nilli - Ravi	Surti
Morning	3.42 ± 0.02	3.38 ± 0.02	3.93 ± 0.04
Evening	3.38 ± 0.02	3.32 ± 0.01	3.85 ± 0.02
Total	3.4 ± 0.04	3.35 ± 0.015	3.89 ± 0.03

Table 4

Variations of Protein (%) in Morning and Evening in different breeds of buffaloes.

These findings are consistent with studies by Ahmad et al. (2008), Arora et al. (2013), Heimei (2011), and Sodi et al. (2008), who also observed the influence of non-genetic factors on the milk composition of Murrah Buffaloes. The result of this study showed an average protein content of 3.81±0.02% in pooled Buffalo milk. The protein content in Murrah and Nili Ravi Buffalo milk in this study was more or less similar to the data reported by Misra et al. (2008), which found an overall mean protein percentage of 4.09±0.07%. However, the effect of protein percentages varied due to seasonal influences on the milk compositions of various breeds of Buffaloes in the sub-Himalayan region, as reported by Misra et al. (2008). Their study analyzed protein contents from fifty samples collected from each season from Buffalo herds, revealing an average total protein content of 3.93±0.05% in Nili Ravi Buffalo milk, 3.92±0.07% in Bhadawari, 3.87±0.05% in Mehsana, and 4.03±0.05% in Murrah Buffalo milk.

The findings of the present study do not align with those of Enb et al. (2009), Imran et al. (2008), and Mahmood and Usman (2010). However, Liang et al. (2013) observed and reported higher protein content in the raw milk of various breeds of Buffaloes, such as 5.75% for Murrah, 5.14% for Nili Ravi, 5.78% for Hybrid F¹, and 5.58% for Multiple Generations, which were significantly higher compared to the results of this study.

Lactose

It has been revealed that the lactose content in the milk of Murrah, Nili Ravi, and Surti breeds in the morning ranged from 5.10, 5.00, and 5.37, respectively, while in the evening it ranged from 4.99, 5.04, and 5.25, respectively. The high to low trend of lactose percentage observed in the milk of these breeds shows that Nili Ravi had significantly ($P < 0.05$) more lactose content than Murrah in both the morning and evening. Similarly, when considering the cumulative morning and evening averages, the lactose content was significantly ($P < 0.05$) higher in Nili Ravi (5.06) followed by Murrah (4.95). The Surti breed exhibited the highest lactose content among the three breeds.

Time/Breed	Murrah	Nilli - Ravi	Surti
Morning	5.05 \pm 0.03	5.10 \pm 0.02	5.37 \pm 0.04
Evening	4.99 \pm 0.01	5.04 \pm 0.02	5.25 \pm 0.02
Total	5.02 \pm 0.02	5.07 \pm 0.02	5.31 \pm 0.03

Table 5

Variations of Fat (%) in Morning and Evening in different breeds of buffaloes.

These findings are in agreement with studies by Heimei (2011), Han et al. (2012), Ahmad et al. (2013), Czyszter et al. (2012), Lujerdean et al. (2008), Enb et al. (2009), Imran et al. (2008), and Mahmood and Usman (2010). They reported the chemical compositions of milk samples from Buffaloes in different areas of Gujarat and Pakistan and found the lactose content to be around 5.41%. Hanmante et al. (2003) observed significant effects ($P < 0.05$) of different breeds in Buffaloes and analyzed 200 milk samples of Marathwadi Buffalo, finding the milk lactose content to be $5.033 \pm 0.01\%$. The range of milk composition varied from 3.02% to 5.40%. The lactose content observed in Murrah Buffalo milk is consistent with the results reported by Sodi et al. (2008), who found an average lactose content of $4.83 \pm 0.01\%$ in pooled Buffalo milk.

Density

It has been revealed that the density of the milk of Murrah, Nili Ravi, and Surti breeds in the morning ranged from 30.14 to 30.33, 30.33, and 30.10, respectively, while in the evening it ranged from 29.10 to 29.16, 29.16, and 29.05, respectively. The average density of Nili Ravi and Murrah milk was almost similar both in the morning and evening, indicating non-significant differences ($P > 0.05$). Similarly, when considering the cumulative morning and evening averages, the differences in total density were also non-significant ($P > 0.05$) between Nili Ravi (29.29) and Murrah (29.12). The Surti breed exhibited slightly lower density compared to the other two breeds.

Time/Breed	Murrah	Nilli - Ravi	Surti
Morning	1.031 ^c \pm 0.006	1.030 ^a \pm 0.02	1.030 ^a \pm 0.004
Evening	1.028 ^c \pm 0.001	1.028 ^a \pm 0.001	1.028 ^a \pm 0.002
Total	1.030 \pm 0.006	1.029 \pm 0.002	1.029 \pm 0.003

Table 6

Variations of Fat (%) in Morning and Evening in different breeds of buffaloes.

These findings are in agreement with a study by Chandrakar et al. (2018), who examined the quality of raw Buffalo milk in four districts of Chhattisgarh and investigated the effects of different locations, stages of lactation, and parity on milk components of Buffaloes. The study collected a total of 112 milk samples from four different districts and various stages of lactation (early, mid, and late) and parity (1, 2, 3, 4, and above). Their findings were similar to our study, showing an overall milk density of 30.25.

Overall, the density of the milk in the morning and evening did not exhibit significant variations among the three breeds, indicating similar density levels across the different samples.

Freezing Point

It has been revealed that the freezing point of the milk of Murrah, Nili Ravi, and Surti breeds in the morning ranged from 0.577 to 0.569, 0.569 to 0.543, and 0.564, respectively. In the evening, the freezing point ranged from 0.543 to 0.540, 0.540 to 0.543, and 0.559, respectively. The cumulative percentages of the morning and evening average freezing point of Murrah and Nili Ravi milk were similar, indicating non-significant differences ($P > 0.05$). The freezing point values obtained in this study are consistent with the findings of Sahai (1996), Terramocchia et al. (1999), Di Francia et al. (2007), Braun and Preuss (2008), and Pavel and Guvan (2011).

Time/Breed	Murrah	Nilli - Ravi	Surti
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Morning	0.573 ± 0.002	0.556 ± 0.002	0.564 ± 0.001
Evening	0.541 ± 0.004	0.541 ± 0.002	0.559 ± 0.001
Total	0.557 ± 0.003	0.548 ± 0.002	0.561 ± 0.001

Table 7

Variations of Freezing Point (%) in Morning and Evening in different breeds of buffaloes.

Braun and Preuss (2008) observed the freezing point of Buffalo milk in Germany and reported a range of -0.551°C to -0.514°C. Pavel and Guvan (2011) found an overall mean freezing point of 0.546°C in their study on the effects of seasons on the freezing point of dairy farm milk samples collected from April to December. The freezing point varied throughout the seasons, with values ranging from 0.579°C in spring to -0.546°C in October.

However, the findings of the present study are not in agreement with Ahmad et al. (2008), who observed the physicochemical properties of raw pooled Buffalo milk from different areas of Pakistan and reported a freezing point range of -0.526°C to 0.514°C.

Overall, the freezing point of the milk samples from the Murrah, Nili Ravi, and Surti breeds did not show significant differences, suggesting similar freezing point values among these breeds.

Titratable Acidity

It has been revealed that the percentage titratable acidity of the milk of Murrah, Nili Ravi, and Surti breeds in the morning is 0.200, 0.191, and 0.175, respectively and in the evening, the titratable acidity is 0.200, 0.191, and 0.173, respectively. The average titratable acidity percentage was significantly ($P < 0.05$) higher in Murrah compared to the other breeds, with values of 0.200 in the morning and 0.198 in the evening. Nili Ravi had an average titratable acidity of 0.191 in both morning and evening. The trend of titratable acidity observed in these breeds is as follows: Murrah had higher titratable acidity compared to Nili Ravi and Surti breed.

The cumulative morning and evening average percentages of total titratable acidity were also significantly ($P < 0.05$) higher in Murrah (0.200) followed by Nili Ravi (0.191). These findings are in agreement with Sahai (1996), Abou Donia et al. (2010), and Mahmood and Usman (2010), who reported the physicochemical parameters of raw Buffalo milk from different areas of Gujarat and Pakistan and found titratable acidity to be 0.21% lactic acid.

The results obtained in this study for milk acidity are higher compared to the findings of Kamble (2001), who observed the physicochemical properties of Nili Ravi buffalo milk and reported acidity as 0.14% (lactic acid). Masud et al. (1988) reported an average titratable acidity of 0.14% with a range of 0.22% in fifty samples of Buffalo milk. However, Padghan et al. (2003) reported an average acidity of Marathwada Buffalo milk as 0.15±0.04%.

Time/Breed	Murrah	Nilli - Ravi	Surti
Morning	0.200 ± 0.003	0.191 ± 0.002	0.175 ± 0.004
Evening	0.198 ± 0.001	0.191 ± 0.002	0.173 ± 0.002
Total	0.199 ± 0.002	0.191 ± 0.002	0.174 ± 0.003

Table 8

Variations of Titratable Acidity (%) in Morning and Evening in different breeds of buffaloes.

In contrast, Mishra and Pandey (2008), Mohran et al. (1992), and Ahmad et al. (2013) reported the physicochemical properties of pooled Buffalo milk from different areas of Pakistan and presented an average titratable acidity of 0.162% lactic acid.

Overall, the titratable acidity of the milk samples from the Murrah, Nili Ravi, and Surti breeds varied, with Murrah exhibiting higher acidity levels compared to Nili Ravi and Surti breeds.

pH

It has been revealed that the pH of the milk of Murrah, Nili Ravi, and Surti breeds in the morning ranged from 6.84 to 6.80, 6.78, and 6.81 to 6.80, respectively. In the evening, the pH ranged from 6.80, 6.78, and 6.80, respectively. The average pH was significantly ($P < 0.05$) higher in Murrah milk compared to the other breeds, with values of 6.84 in the morning and 6.80 in the evening. Nili Ravi had an average pH of 6.78 in both morning and evening, while Surti had an average pH of 6.81 in the morning.

The trend of pH observed in these breeds is as follows: Murrah milk had a higher pH than Nili Ravi, while Surti had the highest pH among the three breeds.

The cumulative morning and evening average pH was also significantly ($P < 0.05$) higher in Murrah (6.81) followed by Nili Ravi (6.68). These findings are in agreement with Park et al. (2007), Dubey et al. (1998), Silva et al. (1995), and Ahmad et al. (2008), who reported the effect of acidification on various physicochemical properties of Murrah Buffalo milk and presented pH values of 6.81 ± 0.06 .

Time/Breed	Murrah	Nilli - Ravi	Surti
Morning	6.84 ± 0.06	6.78 ± 0.02	6.82 ± 0.04
Evening	6.80 ± 0.02	6.78 ± 0.02	6.80 ± 0.02
Total	6.82 ± 0.04	6.78 ± 0.02	6.81 ± 0.03

Table 9

Variations of pH (%) in Morning and Evening in different breeds of buffaloes.

The pH values observed in Murrah Buffalo milk are consistent with the results reported by Nader et al. (1996), who found average pH values ranging from 6.86 to 6.97 for Buffalo milk. However, the findings of the present study are not in agreement with those of Imran et al. (2008), who observed various physicochemical properties of Buffalo milk from different areas in Pakistan and found a pH value of 6.93. The pH values of Buffalo milk in this study are lower than the results reported by Mahmood and Usman (2010), who observed physicochemical parameters of Buffalo milk from different areas of Pakistan and found a pH value of 6.75.

In summary, the pH values of the milk samples from the Murrah, Nili Ravi, and Surti breeds varied, with Murrah exhibiting higher pH levels compared to Nili Ravi and Surti breeds.

Specific Gravity

It has been revealed that the specific gravity of the milk of Murrah, Nili Ravi, and Surti breeds in the morning ranged from 1.029 to 1.030, 1.030, and 1.028, respectively. In the evening, the specific gravity ranged from 1.028 to 1.029, 1.029, and 1.027, respectively. The average specific gravity was significantly ($P < 0.05$) higher in Nili Ravi during the morning with a value of 1.030 and in the evening with a value of 1.029. Murrah had an average specific gravity of 1.029 in the morning and 1.028 in the evening, while Surti had an average specific gravity of 1.025 in both morning and evening. The trend of specific gravity observed in these breeds is as follows: Nili Ravi had a higher average specific gravity than Murrah, and Surti had the lowest specific gravity among the three breeds.

The cumulative morning and evening average specific gravity was also significantly ($P < 0.05$) higher in Nili Ravi (1.029) followed by Murrah (1.028). These findings are in line with the data reported by Laxminaryana and Dastur (1968), Han-Gang et al. (1994), Asif et al. (2010), and Padghan et al. (2003), who reported an average specific gravity of Marathwadi Buffalo milk as 1.031.

The specific gravity ranges observed in this study are consistent with the range reported by Mahmood and Usman (2010). However, it should be noted that Rashida et al. (2004) and Arian et al. (2008) observed higher specific gravity values in colostrum (1.061) compared to normal Buffalo milk (1.037).

Time/Breed	Murrah	Nilli - Ravi	Surti
Morning	1.031 ± 0.002	1.030 ± 0.004	1.028 ± 0.003
Evening	1.028 ± 0.002	1.028 ± 0.002	1.027 ± 0.001
Total	1.029 ± 0.002	1.029 ± 0.003	1.027 ± 0.002

Table 10

Variations of Specific Gravity (%) in Morning and Evening in different breeds of buffaloes.

In summary, the specific gravity values of the milk samples from the Murrah, Nili Ravi, and Surti breeds varied, with Nili Ravi exhibiting higher average specific gravity compared to Murrah and Surti breeds. The specific gravity values observed in this study are consistent with previous reports, except for colostrum samples, which showed higher specific gravity values.

4. Conclusion

The research on the physio-chemical properties of milk from different buffalo breeds - Murrah, Nili Ravi, and Surti - revealed significant variations in various parameters. These variations have important implications for the dairy industry and provide insights into the unique characteristics of each breed.

Fat Content: The research showed that Murrah had the highest fat content in both morning and evening milk, followed by Surti, with Nili Ravi having the lowest fat content.

Solid Not Fat (SNF): Similarly, Murrah consistently had the highest SNF content, while Surti exhibited the lowest.

Total Solids: The total solids content followed a similar trend, with Murrah having the highest content, and Nili Ravi and Surti showing progressively lower levels.

Protein Content: In terms of protein content, Surti had the highest percentage, while Murrah and Nili Ravi displayed similar values.

Lactose Content: Nili Ravi had significantly higher lactose content than Murrah, with Surti falling in between.

Density: There was a minimal difference in density between Murrah and Nili Ravi, with Surti having slightly lower density.

Freezing Point: The freezing point showed consistent values among Murrah and Nili Ravi, while Surti had slightly lower values.

Titratable Acidity: Murrah had the highest titratable acidity, followed by Nili Ravi, with Surti showing the lowest values.

pH: Murrah exhibited the highest pH values, followed by Surti, with Nili Ravi having the lowest pH.

Specific Gravity: Nili Ravi had the highest specific gravity, Murrah had slightly lower values, and Surti exhibited the lowest specific gravity.

These findings provide valuable insights into the variations in milk composition among these buffalo breeds. Dairy farmers can make informed decisions about breed selection based on their specific needs, such as fat content, protein content, or other quality parameters. These results can also influence milk processing techniques and product development in India's thriving dairy sector, contributing to improved dairy product quality. Moreover, the research lays the foundation for future studies exploring the relationship between milk composition, environmental factors, and milk yield, further advancing the understanding of dairy science and technology.

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Conflicts of Interest

“The authors declare no conflict of interest.”

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