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Effect of Parity on Milk Yield and Composition Traits in Murrah Buffaloes

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ABSTRACT: This study investigates the influence of parity on milk yield and key compositional traits (fat%, protein%, and lactose%) in Murrah buffaloes. Milk samples were collected from clinically healthy animals across five parity groups (1st to 5th). The average morning milk yield increased from 4.2 ± 0.31 liters in parity 1 to a peak of 5.4 ± 0.45 liters in parity 4, before declining to 4.0 ± 0.34 liters in parity 5. Evening milk yield followed a similar trend, peaking at 5.1 ± 0.46 liters in parity 4. Fat percentage was highest in parity 3 (9.0 ± 0.61%), followed by parity 1 (8.6 ± 0.73%) and parity 5 (8.4 ± 0.68%), with the lowest value observed in parity 2 (7.5 ± 0.66%). Protein content showed a slight decreasing trend from 3.7 ± 0.10% in parity 1 to 3.5 ± 0.09% in parity 5. Lactose content remained relatively stable across parities, ranging from 4.7 ± 0.07% to 4.9 ± 0.08%. Analysis of variance (ANOVA) indicated no statistically significant differences (p > 0.05) in milk yield or composition across parity groups, though weak correlations suggested biologically relevant trends. Mid-parity stages (parities 3 and 4) were associated with optimal milk yield and compositional stability. Notably, the consistent lactose and protein levels in mid-parity milk may favor the enzymatic activation of the Lactoperoxidase (LP) system, offering potential benefits for natural milk preservation, particularly in decentralized or resource-limited places.

Keywords: Murrah buffalo, parity, milk yield, milk composition, Lactoperoxidase system, Dairy farming.

INTRODUCTION

Dairy farming plays a pivotal role in the agricultural economy of India, and buffaloes contribute significantly to total milk production due to their high fat and protein content. Among the various factors affecting lactation performance, parity is considered acritical non-genetic factor (Kumar *et al.*, 2017). Parity refers to the number of parturitions a female has undergone and has been linked to milk yield and compositional changes, especially in terms of fat, protein, and lactose content (Singh *et al.*, 2019). Previous studies suggest that milk yield tends to increase with parity until a certain peak, often around the third or fourth parity, after which it stabilizes or slightly declines due to physiological stress and mammary tissue degradation (Yadav *et al.*, 2021). Simultaneously, milk composition can vary with age and lactation cycle. Fat and protein percentages may decline slightly in older animals due to reduced metabolic efficiency, while lactose levels may rise, possibly reflecting enhanced adaptation to feeding and digestion practices (Choudhary *et al.*, 2018; Pundir *et al.*, 2020). Understanding the effect of parity on milk quality not only provides insight into physiological development and aging in buffaloes but also helps in making informed decisions regarding culling, breeding, and feeding strategies. Despite existing research, there is a lack of comprehensive data that specifically examines this relationship in Murrah buffaloes, the most prominent dairy breed in India known for its superior milk yield and adaptability (ICAR-NDRI, 2020). Therefore, this study aims to analyze the influence of parity on milk yield and key compositional parameters—fat%, protein%, and lactose%—in Murrah buffaloes to support evidence-based improvements in dairy herd management and may offer ideal conditions for enzymatic activation of the Lactoperoxidase (LP) system. This could enhance milk preservation strategies, particularly in decentralized or resource-limited settings.

MATERIALS AND METHODS

Fresh pooled buffalo (Murrah) milk samples were collected from the Livestock Research Centre, National Dairy Research Institute, Karnal, India. Animals were screened for mastitis using the California Mastitis Test (CMT), Somatic Cell Count (SCC), and Hotis Test, ensuring that only healthy animals free from clinical mastitis were selected for sampling (Parmar & Sharma 2024). Samples were analyzed using the automated Lactoscan. The study included data from Murrah buffaloes maintained categorized into parity groups from 1 to 5. Parameters recorded included:

- Milk Yield (AM &PM)
- Fat %
- Protein %
- Lactose %

Statistical Analysis: Descriptive statistics, one-way ANOVA, used to analyze the effects of parity. All analyses were conducted using SPSS version 21.

RESULTS

Milk yield was highest in buffaloes of parity 3 and 4, aligning with physiological maturity. Composition traits varied with less clarity but showed useful trends. Analysis of variance (ANOVA) was employed to determine whether there were significant differences in milk traits across parity groups. The F-statistics and corresponding p-values for each trait indicated that parity did not significantly affect any of the measured variables at a 5% level of significance. Specifically, the F-value for Milk Yield AM was 1.73 with a p-value of 0.146, indicating no statistically significant difference. Milk Yield PM had an F-value of 1.14 and a p-value of 0.350, similarly showing no significant variation. Fat percentage exhibited an F-value of 0.79 with a p-value of 0.559, and Protein percentage recorded an F-value of 0.69 with a p-value of 0.633. Although not statistically significant, these values suggest some biological variability across parity levels. Pearson correlation analysis was used to assess the strength and direction of the linear relationship between parity and milk constituents. The results showed very weak to weak correlations: Lactose% showed a very weak positive correlation (r = +0.062), indicating a minimal increase with increasing parity. Protein% had a weak negative correlation (r=-0.149), suggesting a slight decline as parity increased .Fat% also showed a very weak negative correlation (r = -0.107). These findings highlight that although statistically subtle, the physiological trends across parities may still carry practical relevance in herd management.

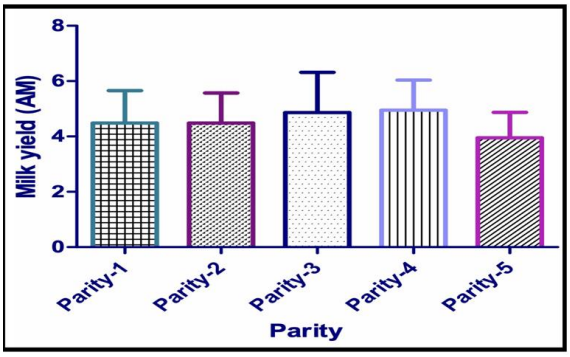

Fig. 1. Morning Milk Yield Across Different Parities.

Fig. 1 illustrates the average morning milk yield (AM) across five parities . Milk yield shows a gradual increase from parity 1 (4.2±0.31L) and parity 2 (4.3±0.39L) to a peak at parity 3 (5.1±0.56L) and parity 4 (5.4±0.45L), indicating improved lactation performance with increasing parity. However, a decline is observed at parity 5 (4.0±0.34L), suggesting that milk production may decrease beyond the fourth parity. This trend highlights the influence of parity on milk yield, with optimal performance observed in the mid-parties.

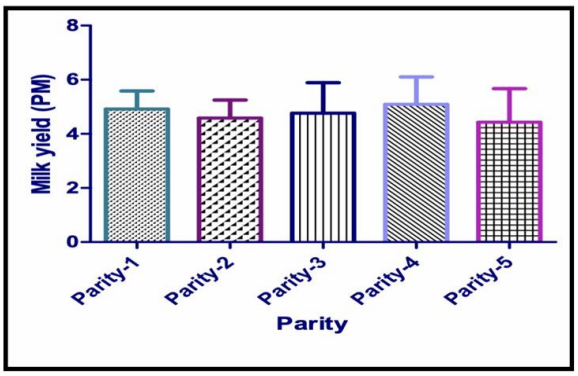

Fig. 2. Evening Milk Yield Across Different Parities.

Fig. 2 represents the average evening milk yield (PM) across five parities. Milk yield remains relatively stable across parities 1 to 4, with slight increases from parity 1 (4.7±0.37L) to parity 4 (5.1±0.46 L). Parity 3 (4.9±0.54 L) and parity 2 (4.6±0.41L) also show comparable yields, suggesting consistent lactation during evening milking across mid-parities. A marginal drop is observed at parity 5 (4.4±0.43 L), indicating a possible decline in milk yield in later reproductive stages. Overall, evening milk production shows moderate variation, with the highest yield observed at parity 4.

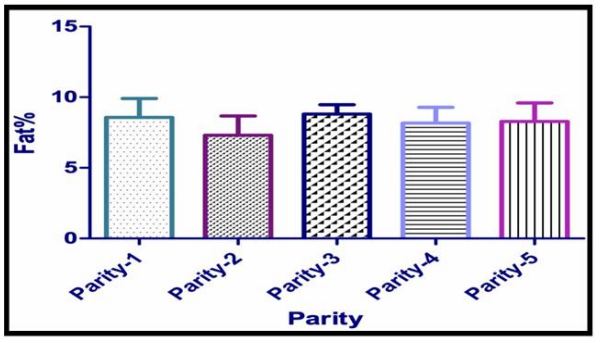

Fig. 3. Milk Fat Percentage Across Different Parities.

Fig. 3 displays the variation in milk fat percentage across five parities. The highest fat content is recorded in parity 3 (9.0 ± 0.61%), followed closely by parity 1 (8.6 ± 0.73%) and Parity 5 (8.4±0.68%) while parity 4 maintains a moderate fat percentage (8.2±0.71%). These results suggest that fat percentage peaks during mid-parities, particularly the third, indicating improved milk quality during these reproductive stages.

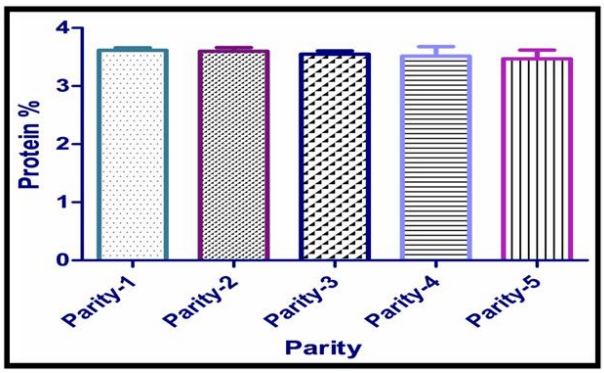

Fig. 4. Milk Protein Percentage Across Different Parities.

Fig. 4 illustrates the protein content in milk across five parities, showing minimal fluctuations. Parity 1 recorded the highest protein percentage (3.7±0.10%), followed closely by parity 2 and parity 3 (both around 3.6±0.08%). Parity 4 (3.5±0.12%) and parity 5 (3.5±0.09%) showed slightly lower values. Overall, the protein content remained fairly stable across parities, indicating consistent milk quality regardless of parity, with a marginally higher protein concentration observed in early lactation.

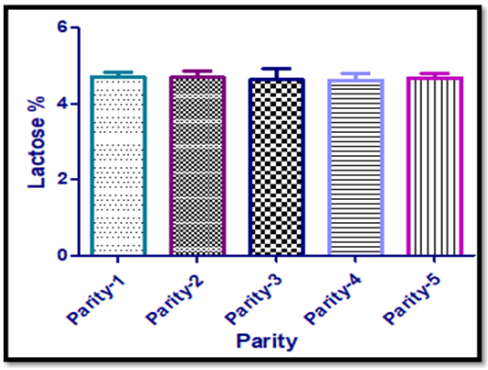

Fig. 5. Milk Lactose Percentage Across Different Parities.

Fig. 5 presents the lactose percentage in milk across five parities, showing minimal variation. All groups maintained relatively consistent lactose levels, ranging from 4.7% to 4.9%, with parity 2 and parity 5 showing the highest values (4.9±0.08%), and parity 4 slightly lower (4.7±0.07%). The near uniformity in lactose content across parities suggests that parity has negligible influence on milk lactose concentration, reflecting stable carbohydrate content regardless of reproductive stage.

DISCUSSION

These findings align with existing literature. For instance, Singh *et al*. (2019) reported that milk yield in Murrah buffaloes typically increases with parity up to the third or fourth lactation and then gradually declines. Our study observed a similar pattern, with average morning milk yield increasing from 4.2 ± 0.31 L in parity 1 to a peak of 5.4 ± 0.45 L in parity 4, and then declining to 4.0 ± 0.34 L in parity 5. Evening milk yield followed the same trend, peaking at 5.1 ± 0.46 L in parity 4 and decreasing thereafter. These patterns are also supported by Yadav *et al*. (2021), who attributed increased milk production during mid-parity to physiological maturity and optimal udder development. Recent findings by Akdağ *et al*. (2024) further emphasize the role of improved feeding strategies, irrespective of parity, in enhancing milk fat content and overall yield in Anatolian buffaloes.

In terms of milk composition, fat percentage was highest in parity 3 (9.0 ± 0.61%), followed by parity 1 (8.6 ± 0.73%) and parity 5 (8.4 ± 0.68%), with the lowest in parity 2 (7.5 ± 0.66%). Though ANOVA did not indicate statistically significant variation in fat% ($F = 0.79$, $p = 0.559$), the weak negative correlation ($r = -0.107$) suggests a biologically relevant trend. This agrees partially with Yadav *et al*. (2013); Brar *et al*. (2022), who noted increasing fat content with parity in advanced lactations. However, Pawar *et al*. (2012) found fat variation to be more season-dependent and reported no consistent increase with parity, underlining the complexity of trait interactions. The observations of Kalwani *et al*. (2024), who reported negligible dietary effects on milk composition across parities in Murrah buffaloes, further underscore the multi-factorial nature of compositional traits.

Protein content decreased gradually from 3.7 ± 0.10% in parity 1 to 3.5 ± 0.09% in parity 5. The weak negative correlation ($r = -0.149$) and lack of statistical significance ($F = 0.69$, $p = 0.633$) suggest minor compositional changes that may be associated with reduced mammary efficiency in later parities. Choudhary *et al*. (2018) similarly reported a decline in protein content with increasing parity, attributing it to secretory tissue degeneration and altered endocrine responses. In contrast, Yadav *et al.* (2013) found stable protein values across parities, highlighting possible environmental or management-based variability in findings.

Lactose content was relatively stable across parities, ranging from 4.7% to 4.9%. The highest lactose levels were seen in parities 2 and 5 (4.9 ± 0.08%), and the lowest in parity 4 (4.7 ± 0.07%), with a very weak positive correlation ($r = +0.062$). These trends are supported by Pundir *et al*. (2020), who noted improved ruminal fermentation and feed utilization in higher-parity animals, leading to slightly higher lactose synthesis. The observations of Atigui *et al*. (2024), who reported parity-related differences in milk flow behavior in Mediterranean buffaloes, suggest that physiological changes in mammary kinetics could also influence milk component profiles over successive lactations.

Although the ANOVA results showed no statistically significant effects of parity on milk yield or composition traits, the compositional uniformity observed in mid-parity buffaloes has practical relevance. The combination of stable protein and lactose levels during parities 3 and 4 makes this stage biochemically favorable for Lactoperoxidase (LP) system activation, which relies on lactoperoxidase enzyme and hydrogen peroxide generated via microbial/enzymatic metabolism of lactose. This suggests that mid-parity milk may be better suited for LP-based milk preservation, especially in resource-limited or decentralized milk collection environments where cold storage is unavailable.

CONCLUSIONS

Though parity did not show statistically significant effects on milk yield and key composition traits, weak correlations and trends provide practical insights. Regular parity-based assessments can enhance productivity and milk quality management in dairy herds. Monitoring parity can support more precise feeding and culling decisions. Parities 3 and 4 showed a balance between yield and quality, implying this stage as optimal for peak production.

PRACTICAL IMPLICATIONS

Among all the milk composition parameters evaluated in this study, lactose content exhibited the highest stability across parities, ranging narrowly from 4.7 ± 0.07% to 4.9 ± 0.08%**.** This uniformity is particularly significant for the Lactoperoxidase (LP) system**,** a natural antimicrobial mechanism in raw milk preservation. The LP system requires two key components: the lactoperoxidase enzyme and hydrogen peroxide, which is often generated through microbial metabolism of lactose. The consistently high and stable lactose levels, regardless of parity, ensure a reliable substrate base for hydrogen peroxide generation, thus facilitating effective enzymatic activation of the LP system.

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