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Impact of chelated minerals supplementation on the reproductive performance of Murrah buffalo heifers

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ABSTRACT

This study examines the impact of chelated mineral supplementation on the reproductive performance of growing Murrah buffalo heifers. Chelated minerals, known for their enhanced bioavailability and absorption, are administered to assess their potential to improve the reproductive outcomes. The study's objective was to assess how supplementing Murrah buffalo heifers with chelated minerals affected them. Fifteen healthy heifers aged between 22 to 28 months were randomly selected and divided into three groups based on their body weight and age. Group T1 (control) received a standard diet which included seasonal green fodder, wheat straw, and conventional concentrate mixture with 2% mineral mixture. Groups T2 and T3 received the same diet, but the inorganic minerals in the concentrate mixture were replaced with 50% and 100% chelated minerals, respectively. The feeding trial lasted 120 days (13th March to 13th July, 2015), during which reproductive parameters including age at first heat, age at first conception, and conception rate were monitored. The results revealed that the onset of the first heat occurred earlier in group T2 (125.8±22.3 days) compared to T1 (160.4±16.6 days) and T3 (152.0±9.4 days), although the difference was statistically non-significant ($p>0.05$). Similarly, there were no significant differences ($p>0.05$) in the days to conceive between the groups (T1: 183.2±28.4 days, T2: 198.8±56.4 days, T3: 179.0±25.6 days). While T2 (2.2±0.5) had more services per conception than T1 (1.6±0.4) and T3 (1.6±0.4), the difference was not statistically significant. Replacement of inorganic minerals with chelated minerals did not demonstrate a significant beneficial effect on the reproductive performance of Murrah buffalo heifers.

Key words: Chelated mineral, heat, Murrah buffalo heifers, service

INTRODUCTION

India boasts the world's largest buffalo population and ranks first in milk production, yielding 230.58 million metric tons in 2022-23. The per capita milk availability in the nation stands at 459 grams per day (Anon. 2023). Nonetheless, animal productivity per capita remains notably low, primarily attributed to sub-optimal genetic traits and compromised nutritional status among dairy animals. Anestrous behaviour, repeated breeding, and infertility are among the metabolic illnesses and reproductive inefficiencies that are exacerbated by these circumstances (Bach, 2019). Poor growth rates, weakened immunity, lower milk yield, and a variety of reproductive diseases in dairy animals are primarily caused by mineral deficiencies (Bindari et al., 2013). Understanding the impact of macro and micro-mineral supplements on dairy cow production efficiency has been the subject of much research over the past years (Griffiths et al., 2007; Garg et al., 2008). Dairy animals have been shown to have deficient syndromes as a result of the depletion of several minerals in the soil and grown fodder (Sharma et al., 2009).

Reproductive performance influences the production efficiency of farm animals, with mineral status playing a crucial role, particularly micro-minerals, in this regard (Kellogg et al., 2003; Nocek et al., 2006; Defrain et al., 2009; Overton & Yasui, 2014). Many studies (Chester-Jones et al., 2013; Rowe et al., 2014) have demonstrated that organic mineral supplementation improves reproductive performance; nevertheless, other reports reveal either no benefit or negative effects (Griffiths et al., 2007; Shinde et al., 2012). Supplementing cows with organic trace minerals lowers their number of services per conception and increase conception rates, according to meta-analyses (Ballantine et al., 2002; Stanton et al., 2000; Rabiee et al., 2010). Furthermore, the effects of organic minerals differ with age; young cows typically perform better during reproduction, while older cows might not (Lamb et al., 2008). Chelated iron supplementation in sows has resulted in a shorter weaning-to-estrus interval, heavier piglets at birth and weaning, fewer stillborn piglets, and a significantly lower mortality rate. These outcomes have been attributed to enhanced metal transfer into the embryo and across the placenta (Rowe et al., 2014). Furthermore, compared to inorganic mineral supplementation, organic trace element supplementation resulted in identical pregnancy rates and the number of services per conception, as well as shorter calving-first service and calving-conception intervals (Ramos et al., 2012).

The chelated mineral mixture increased the percentage of heifers in estrus, improved conception rates, and enhanced fertility, while reducing early embryonic mortality and uterine infections (Kropp, 1990; Manspeaker et al., 1987; Bosseboeuf et al., 2006). Garg et al. (2008) found that adding vitamins to chelated minerals promoted early signs of estrus. This mixture may also treat anoestrus and repeat breeding issues in dairy animals (Butani et al., 2016). Thus, the current study aims to assess how supplementing with chelated mineral mixtures affects the reproductive capabilities of Murrah buffalo heifers.

MATERIALS AND METHODS

Fifteen buffalo heifers aged between 22 to 28 months were carefully chosen from the buffalo farm of the Department of Livestock Production Management, Lala Lajpat Rai University of Veterinary Sciences, Hisar. Prior to the commencement of the study, all selected buffalo heifers underwent deworming against internal parasites and were treated with insecticide spray to prevent external parasites. Following a preliminary adjustment period of ten days, during which the heifers acclimated to their new environment, they were individually weighed and stratified into three groups based on their proximity in body weight and age (Table 1). The feeding trial spanned 120 days (13^{th} March to 13^{th} July 2015), during which experimental buffalo heifers were housed in well-ventilated sheds and individually chained for controlled feeding.

Chelated minerals sourced from a reputable private firm in the local market were utilized for the experiment. The nutritional requirements of the buffalo heifers were meticulously addressed by providing a balanced diet comprising concentrate mixture, green fodder, and wheat straw, adhering to the guidelines outlined by the Indian Council of Agricultural Research (ICAR), as documented by Ranjhan (1998). Overall, the experimental setup ensured optimal conditions for observing and assessing the impact of dietary interventions on the reproductive performance of the buffalo heifers over the designated trial period. Throughout the trial period, reproductive parameters such as the onset of first estrus (age at first heat), the age at which conception occurred for the first time (age at first conception), and the frequency of successful artificial insemination (AI) leading to conception were meticulously documented.

The recorded reproductive data were subjected to rigorous analysis following the established statistical protocols detailed by

Snedecor and Cochran (1994), utilizing optimized statistical methodologies. The data analysis was conducted using Analysis of Variance (ANOVA). The statistical procedures were executed using the SPSS software program, version 20.0, with the level of statistical significance set at $P<0.05$.

Table 1. The buffalo heifers in different treatment groups

Treatment	Provision of feed and fodder
T1 (Control)	Wheat straw + seasonal green fodder + conventional concentrate mixture having 2 % mineral mixture
T2	Wheat straw + seasonal green fodder + 50 % of the 2% mineral mixture in conventional concentrate mixture of control group replaced with chelated minerals.
T3	Wheat straw + seasonal green fodder + 100 % of the entire 2% mineral mixture in conventional concentrate mixture of control group replaced with chelated minerals.

RESULTS AND DISCUSSION

The reproductive traits data, as delineated in Table 2 and graphically in Fig. 1, demonstrated noteworthy observations. Specifically, the time elapsed until the onset of the first estrus post-initiation of the feeding trial was notably shorter for the T2 group (125.8±22.3 days) in comparison to the T1 and T3 groups (160.4±16.6 days and 152.0±9.4 days, respectively). Statistical analysis, however, did not show any appreciable variations between the groups ($p>0.05$). Similarly, for the T1, T2, and T3 groups, the time to conception after the trial started was noted as 183.2±28.4 days, 198.8±56.4 days, and 179.0±25.6 days, respectively. Yet, statistical analysis indicated no significant discrepancies among the groups ($p>0.05$). Regarding the number of artificial inseminations (AI) required per conception, it was observed that the T2 group, fed with a 50% chelated mineral diet, exhibited a slightly higher average (2.2±0.5) compared to the T1 and T3 groups (1.6±0.4 for both). However, these differences were deemed statistically non-significant.

The outcomes of the current investigation elucidate that reproductive performance metrics such as the age at first estrus, age at first conception, and artificial inseminations per conception remained unaffected by the complete substitution of inorganic minerals with chelated minerals. On the other hand, it was noted that heifers supplemented with 50% chelated minerals reached pubertal age earlier than the control group. This aligns with findings reported by Yasui et al. (2014), where supplementation of organic manganese, zinc and copper in cows did not exhibit significant improvements in uterine health.

Stanton et al. (2000) found that during mating seasons, beef cows fed with organic mineral supplementation had higher conception rates, which is in contrast to our findings. In a similar vein, Fourty first-calf Holstein heifers were used in a study by Manspeaker et al. (1989), who splited the animals into groups and provided either a control diet or a control diet plus an amino acid-chelated mineral supplement. Additional iron, manganese, copper, zinc, potassium, and magnesium were supplied via the chelated supplement. Their research, conducted from approximately 30 days prepartum until confirmation of pregnancy by rectal palpation, revealed a significantly lower incidence of peri glandular fibrosis (a pathological response characterized by improper endometrial tissue regeneration postpartum) in heifers receiving

Table 2. Impact of chelated mineral mixture supplementation on reproductive performance in Murrah buffalo heifers

Groups	Days to 1st heat	Age at first Conception (days)	Number of AI/ Conception	Significance
T1	160.40±16.60	183.20±28.43	1.60±0.40	0.356
T2	125.80±22.38	198.80±56.39	2.20±0.49	0.932
T3	152.00±9.90	179.00±25.63	1.60±0.40	0.543

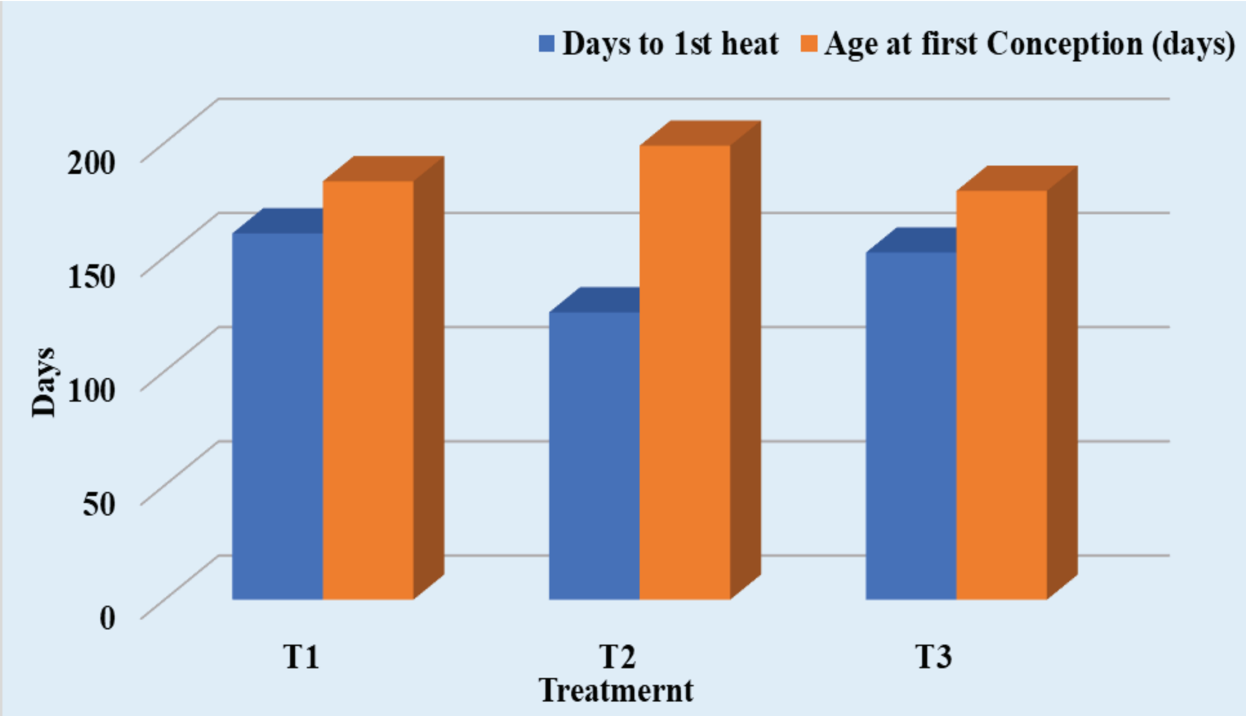

Fig. 1. Impact of chelated mineral mixture supplementation on reproductive performance

chelated minerals (10% compared to 58% in the control group). While not statistically significant, heifers supplemented with chelated minerals tended to exhibit higher ovarian activity and lower embryonic mortality. Kantwa et al. (2021) reported that there was a significant ($P<0.01$) difference in the reproductive features of the treatment group of dairy animals compared to the control group. These traits included the onset of first estrus after calving, the number of artificial inseminations (AI), and the natural services required for conception. The treatment group's pooled average onset of first estrus after calving was found to be lower (91.30 days) than that of the control group (115.80 days), indicating a statistically significant difference ($P<0.01$). The treatment group exhibited a significant ($P<0.05$) decrease in the number of AI/Natural services required per conception as compared to the control group. The group treated with chelated minerals had a significantly lower service per conception than the control group. These results are consistent with those of Singh et al. (2020), Kumar et al. (2020), Tanwar et al. (2019), and Gupta et al. (2017), who also noted reduced postpartum estrous in the group supplemented with mineral mixture compared to the control. First postpartum estrus was found to begin 24.50 days earlier on average in the treated group than in the control group. Tanwar et al. (2019) have observed similar findings in buffaloes. Tanwar et al. (2019), Bhuvaneswari (2019), and Gupta et al. (2017) similarly reported similar results, showing a substantial difference in the number of AI/services per conception between the dairy cow groups supplemented with mineral combination and the non-supplemented group.

These scientific insights underscore the complex interplay between dietary chelated mineral composition and reproductive outcomes in buffalo, highlighting the need for further investigation into the nuanced impacts of chelated mineral supplementation on reproductive health and performance.

CONCLUSION

The current study concludes that although the complete replacement of inorganic minerals with chelated minerals did not significantly affect reproductive performance metrics, it was observed earlier pubertal age in heifers and shortened the service period receiving supplementation of chelated minerals, numerically. These findings underscore the necessity for further research with larger sample sizes and extended durations to justify the benefits of chelated mineral supplementation over conventional mineral sources in animal diets.

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