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Effect of Area Specific Mineral Mixture Feeding on Reproductive Performance and Milk Yield in Crossbred Cattle Reared under Intensive Farm Condition

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ABSTRACT

The present study to find out the effects of supplementation of the area-specific mineral mixture on productive and reproductive performances of crossbred cows during pregnancy to lactational transition phases including the birth weight of calf, first postpartum estrus, conception rates, milk yield, and milk composition. For these purposes, 18 pregnant crossbred cows were selected and divided into two groups *viz*., Control-T0 (N=9) and Treatment-T1 (N=9) supplemented with 0 and 30 g ASMM/ animal/day starting from 3 months prior to the expected date of parturition to till first post-partum oestrus, respectively. Milk samples were taken fortnightly. Overall mean birth weight of calf born in T0 and T1 group was 20.14 ± 1.70 and 19.56 ± 1.09, respectively and there was non-significant (P>0.05) difference between the two groups. The onset of first post-partum heat was 108.13 ± 16.23 days and 92.29 ± 9.95 days respectively. Conception rate post-partum heat was 22.22% and 77.78% respectively. The overall mean of total fat % in T0 and T1, was 4.01 ± 0.20 and 5.40 ± 0.22, total solid % was 13.03 ± 0.31 and 14.72 ± 0.37 %, solid not fat 9.02 ± 0.14% and 9.22 ± 0.31% and total ash was 0.62 ± 0.03% and 0.65 ± 0.02%, crude protein was 3.35 ± 0.10% and 3.63 ± 0.14%, respectively and was statistically non-significant (P>0.05) among the groups. Overall Milk yield was 9.42 ± 0.54 and 10.76 ± 0.37 kg/days, respectively, and was statistically significant (P < 0.001). This study indicated that dietary supplementation of the area-specific mineral mixture in the crossbred cattle, improved the productive and reproductive performances during last trimester to first post-partum oestrus.

HIGHLIGHTS

- Feeding of ASMM improved productive and reproductive performances in crossbred cows.
- ASMM supplementation reduced the time of onset of first postpartum estrus and increased conception rate.
- ASMM feeding significantly (p<0.05) increased milk yield.

Keywords: Area specific mineral mixture, crossbred cows, Conception rate, milk components, pregnancy

Livestock sector plays a key role in improving the socio-economic conditions of developing countries (Herrero *et al*., 2013). According to the 20th livestock census, total milch cattle population in the India is 74.18 million and has increased by 9.8 % as compared to the previous census (20th livestock census). Crossbred are animals that have shown best reproduction and productive performance compared to indigenous animal, which is mainly due to recombination and heterosis effect (Sutarno and Setyawan, 2015). The productivity of dairy cows is dependent on

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balanced feeding by providing adequate quantities of all necessary nutrients to meet their requirements for a particular physiological function but in India, animal feeding is traditional in nature and generally depends upon locally available feed resources (Garg *et al*., 2013). Crop residues that constitute a major portion of diet are poor in essential minerals (Garg *et al*., 2008). Supplementation of the mineral mixture is of vital importance for animals and it helps in improving the growth rates, feed utilization efficiency, milk production, reproductive efficiency, resistance against infectious diseases, and also minimizing the incidence of certain metabolic diseases, and reduces inter-calving interval (Mohanta and Garg, 2014). The most deficient minerals supplementation through area specific mineral mixture (ASMM) by assessing the mineral content in feeds and fodders of animals in different agro-climatic zones appear to be the best approach (Selvaraju *et al*., 2009). This approach has been found to improve the reproductive efficiency and health in crossbred cattle under field conditions and this technology has been successfully replicated (Crowe *et al*., 2018). Supplementation ASMM and vitamins are not practised in most parts of the country (Garg *et al*., 2007). Garg and Bhandari (2005) reported low animal productivity and impaired reproductive behaviour due to mineral deficiency and corrected these ailments through supplementation of various deficient minerals. Results of previous experimentations revealed that six minerals are deficient in lower Gangetic part of West Bengal i.e. Ca, P, Cu, Zn, Co and Mn (Ghosh *et al*., 2013), but the effects of supplementing these deficient trace minerals through ASMM on productive and reproductive performance of crossbred cows during the last trimester pregnancy to lactation transition period have not been studied. The present study was, therefore, planned in this direction to evaluate the effects of supplementation of the ASMM on the productive and reproductive performances of crossbred of dairy cows at farm level under intensive management conditions during last trimester of pregnancy to lactational transition phases till the onset of first post-partum oestrus.

MATERIALS AND METHODS

Experiment design and feeding schedule

The entire study was carried out in the Cattle Yard of ICAR-National Dairy Research Institute, Eastern Regional Station, Kalyani, West Bengal India. These are its location coordinates: the farm is situated at 22° 58'30"N Latitude and 88° 26' 4" E Longitude. Kalyani is located at the lower Gangetic basin of West Bengal in Nadia district, 48 km north from Kolkata. The climatic condition is hot humid. The average annual maximum temperature is 32°C and the minimum temperature is 20°C. The maximum humidity is 91% and minimum humidity is 58%. The annual rainfall is around 1250 mm.

A total of 18 crossbred pregnant cows (Jersey × Tharparkar) of last trimester of pregnancy were selected randomly and divided into 2 groups viz., T0 (Control group, n=9) and T1 (Treatment group; n=9). Concentrate feed was offered to each animal as per the NRC recommendation (2001). The animals of the control group were not provided with any ASMM but the treatment group animals were fed with ASMM @ 30 g/day/animal started from 3 months prior to the expected date of parturition till the onset of first post-partum estrus. Area specific mineral mixture consisted of di-calcium phosphate (DCP), Zinc sulphate, Copper sulphate, Cobalt sulphate and Manganese sulphate in the ratio of 3000:40:20:2:1. Immediately after calving, the birth weight of each new-born calf was recorded once a day using a digital weight recording platform.

Sample collection and procedures

All experimental animals were milked twice-a-day (morning and evening) by machine milking method as followed in the institute farm. Milk samples were collected from day-3 postpartum and continued at every fortnight till the commencement of first postpartum estrus. Before taking the samples, the teats were thoroughly disinfected and allowed to dry and 1st 2-3 streaks of foremilk were discarded. Approximately 80-100 ml of milk was collected aseptically in the clean & sterilized sampling bottles twice a day in the morning and evening. Pooled milk samples of morning and evening milking were used for further analysis. 10 ml of the pooled samples were also preserved separately for total protein estimation and the remaining samples were used for other milk components. Milk samples were chemically analyzed for total solids (TS), fat (Butyrometric method), crude protein (Microkjedahl's method), and ash according to AOAC (2005); whereas, Solid Not Fat (SNF) was calculated by differences.

STATISTICAL ANALYSIS

Suitable statistical procedures were followed for analysis of the data recorded under various experiments in this study. Different statistical designs were considered for analysis of data as per Snedecor and Cochran (1994) and analysis was done using SPSS programme.

RESULTS AND DISCUSSION

Effects of ASMM supplementation on different reproductive parameters recorded in the present study have been detailed in Table 1.

Table 1: Effect of area specific mineral mixture feeding on reproductive parameters in crossbred cattle (Mean ± SE)

Parameters	Groups	
	T0	T1
Birth weight (kg)	20.14 ± 1.70[a]	19.56 ± 1.09[a]
Onset of first post-partum estrus (days)	108.13 ± 16.23[b]	92.29 ± 9.95[c]
Conception rate (%)	22.2[d]	77.8[e]

[a,b,c,d,e] values with similar superscripts within each row did not differ (P>0.05).

This study revealed that overall mean birth weight of the calves in control and treatment group of animals were 20.14 ± 1.70 and 19.56 ± 1.09 kg, respectively. Birth weight between the groups did not differ (P>0.05). The findings are in agreement with work done by Olson *et al*. (2009) and Dhakal *et al*. (2012). Improper feeding particularly trace mineral deficiency in the feed during the last phase of gestation could lead to different reproductive disorders like retention of foetal membranes, neonatal weakness and low birth weight (Dhakal *et al*., 2012). In the present investigation, we found that the onset of first post-partum oestrus in control and treatment group was 108.1 ± 16.23 and 92.3 ± 9.95 days, respectively i.e. ASMM supplementation leads to an early onset (P<0.05) of estrus post-parturition. In the present study, it was observed that most of the animals of the treatment group came in to first post-partum estrus, whereas; only four animals of control group exhibited estrus post-parturition. Oestrus signs were detected by visual signs like oedema of the vulva, congestion of mucus membrane, and presence of mucus discharge. Results are in agreement with Mohapatra *et al*. (2012) and Verma (2015) who observed that heifers and cattle supplemented with ASMM exhibited oestrus in higher percent compared to untreated animals. In general, low fertility is associated with delayed or suppressed oestrus commonly found in phosphorus, copper and zinc deficient animals (Smith and Akinbamijo, 2000; Underwood and Suttle, 2003; Dhami *et al*., 2018). Effect of ASSM on conception rate at first postpartum oestrus is one of important parameters to measure the reproductive efficiency.The result of the present investigation clearly showed that supplementation of ASMM increased (P<0.05) conception rate in treatment than control groups (77.78 versus 22.22 %). Our results of early onset of first postpartum estrus in treatment than control animals are similar to the previous work of Koley and Biswas, (2004), Rabiee *et al*. (2010) and Agrawalla *et al*. (2017), who also observed that mineral supplementation reduces the time of onset of first postpartum estrus therby decreases days to first service postparturition and hence improves conception rate in bovine species. Poor nutrition in association with poor reproductive management leads to delayed puberty, inefficient oestrus detection, long post-partum anoestrus, low conception rates, high rates of embryonic mortality, long calving intervals and a general lowering in the fertility of the herd. The improvement in reproductive efficiency may be attributed to more bioavailability of minerals and the beneficial action of minerals on the neuroendocrine axis and reproductive function.

Table 2: Effect of area specific mineral mixture feeding on milk production parameters in crossbred cattle (Mean ± SE)

Perameters	Groups	
	T0	T1
Milk fat	4.01 ± 0.20[a]	5.40 ± 0.22[a]
Total solid (%)	13.03 ± 0.31[a]	14.72 ± 0.37[a]
Solid Not Fat (%)	9.02 ± 0.14[a]	9.22 ± 0.31[a]
Total ash (%)	0.0.62 ± 0.03[a]	0.65 ± 0.02[a]
Crude protein (%)	3.35 ± 0.10[a]	3.63 ± 0.14[a]
Milk yield (kg/days)	9.42 ± 0.54[a]	10.76 ± 0.37 [b]

[a,b] values with similar superscripts within each row did not differ (P>0.05).

Effect of ASMM supplementation on milk constituents in both the groups have been presented in Table 2. The overall mean of fat, total solid, solid not fat, total ash and CP % did not differ between the groups (P>0.05). Similar

findings have also been reported by various researchers (Rabiee *et al*., 2010; Begum *et al*., 2010; Singh *et al*., 2016), who found no significant changes in milk components such as milk protein, milk fat and milk SNF between the supplemented and non-supplemented groups. In the present study, we found that the overall mean milk yield in control and treatment group was 9.42 ± 0.54 and 10.76 ± 0.37 kg/day respectively. Mean value of milk yield was significantly ($p<0.05$) higher in treatment than control groups. This finding is in full agreement with Singh *et al*. (2016), who reported the overall difference in milk yields of control and treatment (ASMM supplemented) groups was significant ($P<0.05$). These findings are also similar to those of Hackbart *et al*. (2010) who reported an increase in milk production in dairy cattle at the mid-lactation stage of milk production. In Indian conditions, Tiwari *et al*. (2013) have reported an increase in milk production as well as increased in total lactation length in cattle post area specific mineral mixture supplementation. Nocek *et al*. (2006) observed an increase in milk production during the second lactation as compared to the first lactation post-mineral supplementation. Sahoo *et al*. (2017) and Saxena *et al*. (2008) also found increased milk yield by supplementation of area specific mineral mixture in dairy cattle of the hilly region. Outcome of our study clearly showed that feeding of the mineral mixture could improve milk production potential of crossbred cows due to an impact on the milk-producing cells in the udder (Gupta *et al*., 2017).

CONCLUSION

Supplementation of area-specific mineral mixture resulted in an early onset of first postpartum estrus, enhanced conception rate and increased the milk yield without any significant effects on milk constituents like milk fat, total solids, total ash, CP, SNF. The addition of specific deficient minerals in the form of ASMM is, therefore, recommended to the feed of the dairy cows preferably during last trimester of pregnancy to obtain better reproductive efficiency and higher milk production.

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