Effect of area specific mineral mixture supplementation on milk yield and reproductive traits of crossbred dairy cattle under sub-tropical region of north eastern India

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Abstract

Nutrients requirement plays a very crucial role in regulating biological systems, immunological, health, lactation and reproductive performance in dairy cattle. Therefore, the present study was conducted to assess the effect of area specific mineral mixture supplementation on milk yield, reproductive performance and economic of dairy cattle for a period of 120 days. Experimental animals were selected randomly from four villages of Dima Hasao district of Assam. Twenty lactating crossbred cattle (n=20) were divided into two groups (10 milch cows/group viz., treatment (T)-supplement of 50gm mineral mixture/cattle/day and control (T-no supplementation) in a completely randomized designed. Results revealed significant (P<0.05) improvement in milk yield by 1.36 litre per day (18.68%), reproductive performance and benefit cost ratio (3.55 vs 3.11) in the studied. Thus, mineral mixture supplementation in the diet of dairy cattle gave better results in improving milk yield and reproductive efficiency for sustainability livelihood in smallholders’ dairy farming in hilly regions.

Keywords: milk yield, reproductive performance, area specific mineral mixture, dima hasao

1. Introduction

India has been the world’s largest milk producer for the last two decades, with a 22.67 percent share of global dairy production. Around 70 million Indian households are projected to be active in dairy production vis-à-vis 150 million households worldwide (FAO, 2020) [1]. The dairy sector is a major subsidiary occupation and source of income for 75 percent of the Indian population, of which 30 percent are poor, living in rural areas (Douphrate et al., 2013) [2]. In many livestock production systems, approximately two-thirds of improvements in livestock productivity can be attributed to improved nutrition (Fitzhugh, 1978) [3]. At present, the country is facing a net deficit of 35.6% green fodder, 10.95% dry crop residues and 44% concentrate feed ingredients to meet requirement of the growing livestock population (Dhawal et al., 2020) [4]. Ca, P, Na, Co, Cu, I and Zn are the minerals most likely to be deficient under grazing conditions (McDowell, 1993) [5]. However, in all types of dairy animals, the effects of mineral deficiency and metabolic disorders have been observed due to lower mineral and vitamins content, available energy, protein, and poor bioavailability of essential macro and micro minerals from different feed stuffs (Bhanderi et al., 2014; Ramachandra et al., 2007; Sharma et al., 2005) [6, 7, 8]. In order to compensate for the low productivity of the animals, farmers fed only the productive animals optimally, and the rest of the animals (male, calves, spent female) are fed lower quantities or imbalanced diet. Nowadays, mineral nutrients play a key player role in controlling biological systems, development, health, lactation and reproduction, and microbial fermentation is well known in the animal rumen (Weiss, 2012; McDowell, 2003) [9, 10]. In rural areas or hilly regions, dairy cattle are largely dependent on grazing and crop residue with little or no additional concentrate or mineral mixture except common salt (Garg et al., 2005) [11]. In the North Eastern Region (NER) of India, the total milk production in the region was 1454.17 thousand tones (17.60 percent) vis-à-vis the country's...
2.2 Animal, Experimental diet and management
All the animals were selected at a mid stage of 2nd lactation, milk yield and parity. A total of twenty lactating crossbred cattle (n=20) were divided into two groups (10 milch cows/group) viz., treatment and control. Animals from the treatment group (n=10) were fed area specific mineral mixture (AAUVETMIN) developed by Assam Agricultural University at the rate of 50 gram/cattle/day, whereas cattle from the control group were not given any supplementation. Composition of area Specific Mineral Mixture (AAUVETMIN) contain calcium (17.60), Phosphorus (7.00), Magnesium (1.50), Zinc (0.13) and copper (0.08) respectively, measured in percentage by mass. Feeding practices by farmers were similar in both the group except the supplementation of AAUVETMIN in the treatment group only. Standard animal management practices were followed in the farmer’s field. Animals were fed green fodder, hay and concentrate feed as per specific recommendation of standard feeding ration schedule (ICAR, 2013) [23]. Water was offered ad libitum throughout the experimental period. The feeding trial was lasted for 120 days.

2.3 Data collection on milk yield, reproductive performance and cost benefit ratio
Milk yield was recorded daily, twice both in morning and evening at 6:00 and 17:00 hours by the farmers and at weekly interval by the researcher. Data on reproductive traits viz. post-partum estrus, service period and number of artificial insemination required for conception were recorded on the basis of dairy cow owner’s response. The benefit cost ratio for all the groups were calculated. A training programme was conducted for the farmers before starting the experiment to educate them for feeding and correct method of data recording on different parameters in the adopted villages.

2.4 Statistical Analysis
The data were analyzed statistically as per Snedecor and Cochran, 1989 [24] and student’s t-test of significance (2 way split analysis of variance) between groups were performed using SPSS for Windows (version 17.0 Microsoft).

3. Results and discussion
3.1 Effects on Milk yield
The experiments were performed with dietary supplementation area specific mineral mixture to find out whether AAUVETMIN will have any effect or any change on milk yield, reproductive performance and benefit cost ratio in crossbred dairy cattle in this hilly region. The observations on milk production, reproductive traits and economic impact on dairy cattle are presented in Table-1. The average milk yield in treated group was found significantly higher (p<0.05) as

| Parameter                                      | Control group(T1) (n=10) | Treatment group(T2) (n=10) | SEM | t-value | Level of significance |
|-----------------------------------------------|--------------------------|-----------------------------|-----|---------|-----------------------|
| 1. Initial (0 day)                             | 7.16*                    | 7.28*                       | 1.08| 1.78    | NS                    |
| 2. Final average (30-120 days)                | 7.28*                    | 8.64*                       | 0.14| 1.25    | *                     |
| 3. Change in milk production (%)              | 4.74                     | 18.68                       | 0.21| 3.67    | NS                    |
| 4. Average milk Fat%                          | 8.88                     | 8.92                        | 0.11| 2.03    | NS                    |

Numbers of observations are given in parentheses. Means bearing the different superscript within a row differ statistically significant; * P<0.05, NS-Non significant
economic analysis of the data revealed that dietary significantly affected milk production of cattle. Pandey et al. (2018) and Noce et al. (2006) also reported that supplementation of area specific mineral mixture increased milk yield 25% in field trials. Similar to the present findings, Hackbart et al. (2010) observed increase in milk production at 14 week supplementation of organic trace minerals to cattle. This finding was in line with Akila et al. (2013) and Senthilkumar et al. (2015) who reported that supplementation of TANUVAS – mineral mixture to a dairy cattle resulted in increase in milk yield by 1.46± 0.14 and one litre per day in cow respectively. Singh et al. (2016) observed significantly higher (p<0.05) milk production in supplemented animal with mineral mixture. However, result indicating that dietary mineral mixture supplementation attributes improved milk production potential of cattle could be due to having impact on the mammary myoepithelial cells-smooth muscle alpha-actin (ACTA2) in the udder during lactation. Further, synergistic effect of macro and micro elements contribute in the working of memory cells to enhance their productivity. This finding was in accordance with Ghosh et al. (2016) and Rohilla et al. (2007) observation. The present results support the findings of Rabiee et al. (2010) and Mohsina et al. (2017) observed no significant differences in milk fat % and milk SNF % between the supplemented and non-supplemented groups of animals.

3.2 Effects of reproductive performance

Reproductive traits i.e. onset of first Post-partum estrus after calving, service period and number of insemination per conception were also recorded during the experimental period as shown in Table- 2. These reproductive traits significantly (P<0.05) differed in the treatment group of dairy animals as compared to control group. The supplemented group of animals voluntary waiting period (48.37 days) was observed slightly lower than the control group (63.21 days). On average onset of first postpartum estrus was observed to occur 14.84 days earlier in the supplement animals as compared to control group. Moreover, the mineral mixture fed group with a service period (62.37 days) was also found significantly (P<0.05) lower than the control group (86.21 days). Similar findings were also reported by Sivara (2019), Gupta et al. (2017), Sahoo et al. (2017) (37), Mohapatra et al. (2012) and Devasenat et al. (2010) in crossbred cattle. Significant effect of service period and number of insemination required for conception was evident from the present study. The present results support the findings of Selvaraju et al. (2009) regarding improvement in general health score condition of the cows after area specific mineral mixture supplementation. The improvement in reproductive efficiency in cattle could be attributed due to mineral supplementation as compared to the performance of non-supplemented group was very clear in this study.

| Parameter | Control group(T1) (n=10) | Treatment group(T2) (n=10) | SEM | t-value | Level of significance |
|-----------|--------------------------|---------------------------|-----|---------|-----------------------|
| Reproductive Traits |               |                           |     |         |                       |
| 1. Onset of first post-partum estrus (days) after calving | 63.21*a | 48.37*b | 6.83 | 24.16 | *                     |
| 2. Service period (days) | 86.21*a | 62.37*b | 7.89 | 28.74 | *                     |
| 3. Number of insemination/conception | 3.82 | 1.73 | 0.65 | 5.82 | **                    |

Numbers of observations are given in parentheses. Means bearing the different superscript within a row differ statistically significant; * P<0.05; ** P<0.01, NS-Non significant

3.3 Cost of milk production and Benefit Cost ratio (BCR)

The economic analysis of the data revealed that dietary supplementation of area specific mineral mixture enhances the milk yield by 18.68 % per day in treated group. It could be inferred from Table-3 that benefit cost ratio was higher (p<0.05) in supplement animals as compared to control group. The feeding cost of per litre of milk was lower (₹ 22.73) in treatment group as compared to control group (₹ 25.80). Gross return from sale of milk (₹ 691.20 vs 582.40) and net profit litre of milk was found to be higher in treatment group (₹ 57.34) than control group (₹ 54.31). The BCR was also found higher in treatment group as compared to control group (₹ 3.55 vs 3.11). Similar result to the present finding was in accordance with Sivara (2019) in milch cattle.

Table 3: Economics impact of area specific mineral mixture supplementation benefit cost ratio in dairy cattle

| Parameter | Control group(T1) (n=10) | Treatment group(T2) (n=10) | SEM | t-value | Level of significance |
|-----------|--------------------------|---------------------------|-----|---------|-----------------------|
| Milk yield (litre/day) |               |                           |     |         |                       |
| 1. Initial (0 day) | 7.16*a | 7.28*a | 1.08 | 1.78 | NS                    |
| 2. Final average (30-120 days) | 7.28*a | 8.64*b | 0.14 | 1.25 | *                     |
| Benefit cost ratio |               |                           |     |         |                       |
| 1. Cost of feeding /day/cow (₹) | 187.00*a | 194.50*b | 0.52 | 4.78 | *                     |
| 2. Average feed cost per litre of milk production (₹) | 25.68*a | 22.51*b | 6.62 | 24.23 | *                     |
| 3. Gross return from sale of milk (₹/Liter) | 582.40*a | 691.20*b | 3.57 | 12.66 | *                     |
| 4. Net profit per day (₹) | 395.40*a | 496.70*b | 2.68 | 11.46 | *                     |
| 5. Net profit per litre of milk (₹) | 54.31*a | 57.48*b | 7.63 | 36.83 | *                     |
| 6. Benefit: Cost ratio | 3.11*a | 3.55*b | 0.61 | 5.62 | **                    |

Numbers of observations are given in parentheses. Means bearing the different superscript within a row differ statistically significant; * P<0.05; **P<0.01; 6price is varies in hilly region, NS-Non significant
dairy cattle under field conditions not only increases the milk yield, but also reduce cost per litre of milk production and reproductive efficiency and consequently improving socio-economic conditions and can earn more profit from their milch cattle by smallholders’ dairy farmer in hilly region.

5. Conflict of interest
Authors declare that there is no conflict of interests arising from this study.

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