RESEARCH ARTICLE

Effect of area specific mineral mixture supplementation on milk production, biochemical and blood mineral status of Black Bengal goats

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Abstract: This study was conducted to find out the effect of area-specific mineral mixture (ASMM) supplementation on production performances, the biochemical and mineral profile of Black Bengal does during the peripartum period. For this purpose, 20 pregnant does were made into two groups according to the bodyweight viz., Control-T₀ (n=10) and Treatment-T₁ (n=10) and supplemented with 0 and 6 g of ASMM/animal/day, respectively starting from 3 months before the expected date of parturition to till the onset of the first post-partum estrus. Overall mean milk fat, total ash, total solids, solids not fat, milk crude protein and milk yield, blood glucose, non-esterified fatty acids, α -amino nitrogen, phosphorus and serum glutamic pyruvic transaminase concentration were not affected by ASMM supplementation. The overall mean of serum glutamic oxaloacetic transaminase, calcium, copper, and zinc concentration in control (T₀) and treatment (T₁) groups were 127.05±1.27 vs. 132.73±1.26 IU/L, 7.83±0.08 vs. 8.19±0.08 mg/dl, 0.66±0.02 vs. 0.94±0.02 ppm, 0.69±0.01 vs. 0.97±0.02 ppm, respectively and the values were higher in supplemented groups. More studies need to be conducted involving the use of ASMM supplementation to see its effect on the performance of goats.

Keywords: Area-specific mineral mixture, Biochemical, Goat, Minerals, Milk parameters

Introduction

Goats (*Capra hircus*) are reared by farmers for purposes like meat, milk, hides, hair and dung. Black Bengal (*Capra hircus bengalensis*) breed of goat is mostly reared in the eastern and north-eastern region of India. Black Bengal goat is a smaller in body size but highly prolific and meat-type breed of goat and it has many desirable productive traits like early sexual maturity i.e. 6-8 months of age. Nutritional status affects the production potential and reproductive performance of farm animals. More often goats are generally malnourished, particularly with regards to micronutrients. There are twenty-two mineral elements which are very much essential for the health and production of animals (Sharma et al. 2009). Micro-minerals supplementation is required as most of the roughages, greens, concentrates are deficient in trace mineral elements. Ghosh et al. (2013) reported six minerals namely Ca, P, Zn, Cu, Co, Mn are deficient in lower Gangetic part of West Bengal. But till now, the impacts of area specific mineral mixture (ASMM) on production performance of Black Bengal goat have not been studied. Concept of the area specific mineral mixture is a new approach of low input and high output for the end-users. There is an abundant opportunity for exploiting the idea of ASMM for adjusting the deficiency of minerals to obtain the optimal production potential of animals to improve the economy of farmers.

Materials and Methods

Experimental animals

This study was approved by the Institutional Ethics Committee of ICAR-National Dairy Research Institute, India. Twenty numbers of Black Bengal does of 1st parity maintained at ERS-IVRI, Kalyani farm was selected and divided randomly into 2 groups of 10 animals each based on their body weight viz., control (T₀) and treatment (T₁). Control animals were managed under complete grazing with supplementation of concentrate @300 g/head/day starting from three months before parturition until the appearance of the first post-partum estrus. The animals in the treatment group were fed the same diets as in control group except supplemented with ASMM @ 6 g/head/day. This area

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specific mineral mixture was prepared (Table 1) as per Ghosh et al. (2013).

Chemical analysis of feeds

Proximate composition of feeds and fodders was analysed as per AOAC (2005) and cell wall constituents were estimated as per Van Soest et al. (1991). One g representative samples of feeds and fodders fed to goats were taken and tri-acid digestion (HNO_3 : HClO_4 : H_2SO_4 in ratio 3: 2: 1) was done for 1 to 2 h until the solution was clear. The samples were filtered with Whatman 42 filter paper. Then, a sufficient amount of deionized water was added to make the final volume up to 100 ml and samples were analysed by using AAS (Agilent-200 model). Plasma minerals were also analysed.

Analysis of blood parameters

Blood samples were collected at the weekly intervals from the jugular vein into heparinised tubes (20 IU heparin/ml of blood) and centrifuged at 3000 rpm for 30 min at 4°C and plasma was separated and kept in the labelled storage vials of 5 ml capacity and stored at -20°C till analysis. For determination of plasma NEFA, copper soap extraction methods modified by Shipe et al. (1980) was followed. Blood α -amino nitrogen concentration was estimated as per Goodwin (1970). Blood glucose was estimated using commercially available glucose test kit (GOD-POD Method, Span Cogent Diagnostics Ltd., India Product no# 93DP100-74). Alanine amino transaminase (ALT) and aspartate aminotransferase (AST) were estimated by 2, 4-DNPH (Reitman and Frankel Method) using a commercial kit (Span Diagnostics Ltd., India). Blood calcium was estimated using a commercially available calcium kit (Span Diagnostics Ltd., India; product no. 87L S100-60).

Estimation of milk composition

Milk samples were collected on day3 after parturition and then fortnightly till first postpartum heat. Complete milking was done, milk was collected aseptically in the clean and sterile sampling bottles. The milking was done in the morning and evening on the days of sample collection to assess the milk production. 10 ml of milk sample was preserved separately for total protein estimation while, the remaining portion was used for fat, solid-not fat, total solids and ash estimation.

Milk fat was estimated as per Gerber, (1892), the fat percentage was read directly by especially a calibrated butyrometer. For the estimation of milk total solids, 10 g of milk sample was taken in pre-weighted silica crucible placed at 80°C in the hot air oven for overnight. Next day sample with crucible was weighed. Total solids and SNF contents were estimated by the difference. For estimation of milk total ash dry sample with silica, crucible was ashed at 550°C in a muffle furnace for 3 h and total ash was estimated by the difference in weight after ashing of dried sample.

The total nitrogen was estimated (AOAC 2005). Total nitrogen content was multiplied by 6.38 to get milk protein value.

Statistical analysis

Different statistical designs were considered to the analysis of data as per Snedecor and Cochran (1994) and analysis was carried out through the SPSS v16.

Results and Discussion

Mineral status of feeds

The average concentration of calcium (Ca), phosphorus (P) copper (Cu) and zinc (Zn) in green fodder were 0.25%, 0.38%, 7.98 ppm, and 44.46 ppm, respectively with corresponding values of 0.25%, 0.24%, 7.53 ppm, and 38.75 ppm, in concentrate mixture (Table 2). The fodders were deficient in P. The lower P level could be attributed to low pH of the soil (Singh et al. 2011) and the ionic acidity of soil might be induced the formation of a complex with iron and thereby lowered the availability of inorganic P. The critical concentration of Zn for feeds and fodder is 30 ppm (McDowell et al. 1983). Panda et al. (2016) reported content of Mn, Cu and Zn in different feed and fodder varied between 17.14-54.29, 4.55-38.90 and 17.51-47.78 ppm, respectively in the western undulating region of Orissa. Das et al. (2003) reported the feed and fodder available for animal feeds in hill zone region West Bengal were a good source of Cu (17.97-38.73 ppm) moderate source of Ca (0.26-89%) and Zn (31.91-57-35 ppm) and a poor source of P (0.14-17%). Samanta and Samanta (2002) studied in the coastal saline zone of West Bengal and noticed, the available feeds and fodder were sufficient in Ca, Cu and Zn but deficient in P concentration. Similar findings have been reported earlier from the north-eastern part of India (Chander Datt and Aruna Chhabra 2005, Hegde et al. 2016, 2018).

Effect of the area-specific mineral mixture (ASMM) on milk yield and composition

The milk yield and composition were similar in two groups indicating that ASMM supplementation has no significant effect on these variables Table 3. Singh et al. (2016), Wu et al. (2000), Sharma et al. (2002), Rabiee et al. (2010) and Begum et al. (2010) reported non-significant ($P > 0.05$) effect of feeding ASMM on milk components such as protein, fat and SNF of milk on. This

Table 1 Mineral composition of area specific mineral mixture

Minerals	Quantity (g)
Calcium	25.96
Phosphorus	20.08
Zinc	0.529
Copper	0.258
Cobalt	0.027
Manganese	0.011

Table 2 Chemical composition (% DM basis) and mineral status of concentrate and green fodder

Attributes	Concentrate mixture	Green fodder
Dry matter (%)	93.9±0.12	17.13±2.33
Organic matter (%)	93.72±0.07	86.81±0.63
Crude protein (%)	18.94±0.60	12.82±1.73
Ether extract (%)	4.51±0.10	2.66±0.27
Total ash (%)	6.28±0.07	12.92±0.62
Acid Insoluble ash (%)	1.77±0.06	3.36±0.28
Neutral detergent fiber (%)	32.54±1.67	57.6±5.65
Acid detergent fiber (%)	11.20±1.98	35.91±4.08
Calcium (%)	0.25	0.25
Phosphorus (%)	0.24	0.38
Copper (ppm)	7.53	7.98
Zinc (ppm)	38.75	44.46

Table 3 Effect of ASMM on milk yield and milk composition

Attributes	Control (T ₀)	Treatment (T ₁)	P
Milk fat (%)	5.74±0.03	5.86±0.04	>0.05
Total solids (%)	15.16±0.19	15.23±0.15	>0.05
Total ash (%)	0.78±0.01	0.80±0.01	>0.05
Solid not fat (%)	8.64±0.02	8.71±0.03	>0.05
Crude protein (%)	3.63±0.04	3.67±0.05	>0.05
Milk yield (g/day)	281.49±19.91	312.43±16.20	>0.05

finding also supported by Singh et al. (2016), Tiwari et al. (2013), Sahoo et al. (2017) and Nocek et al. (2006) who found the non-significant difference improvement in overall milk yields of control and area specific mineral mixture supplemented group. Singh et al. (2020) reported after introducing (50g) mineral mixture in the feed, average milk yield, fat and SNF content increased by 6.2, 5.3 and 1.8%, respectively, while milk yield increased by 0.49 L/day/animal.

Effect of ASMM on blood parameters

Non-esterified fatty acids (NEFA) and α -amino nitrogen (AAN) values differed non-significantly ($P < 0.05$; Table 4) among groups at different time intervals. NEFA is produced due to the adipose tissue breakdown of fat in response to negative energy status. These circulating NEFAs are absorbed and metabolized for energy. The concentration of NEFA directly reflects the amount of adipose tissue breakdown. Clinical experience suggests serum NEFA concentrations are more sensitive to energy balance changes compared with body condition scoring in growing situations (Van Saun, 2000). Blood α -amino nitrogen indicates protein synthesis status of the animal, but here, the results indicate sufficient protein ration was provided in both groups. Hornick et al. (1996, 1998) reported plasma α -amino nitrogen increases during growth. Mondal and Prakash (2003) reported plasma α -amino nitrogen concentration increases, as the buffalo's age increases. Godara et al. (2015) reported no significant difference ($P > 0.05$) in AAN levels between treatment and control

group when supplemented with an area specific mineral mixture in black Bengal goats.

Blood glucose level was also similar in both the control and ASMM supplemented groups. Similar to our result, Ashry et al. (2012) and Behera et al. (2012) reported that feeding mineral mixture did not have any significant effect on blood glucose concentration. Contrary to our result, Godara et al. (2015) reported a significant difference ($P < 0.05$) in glucose levels between treatment and control group when supplemented with area specific mineral mixture in black Bengal goats.

Effect of area-specific mineral mixture on serum enzymes

The plasma ALT level was similar in two treatment groups, however, plasma AST level was higher ($P < 0.05$; Table 4) group T1 but its concentration was within the normal value. Similar to our results, Godara et al. (2015) reported a significant difference ($P < 0.05$) in AST levels between treatment and control group when supplemented with area specific mineral mixture in black Bengal goats. Sharma et al. (2011) and Exton (1980) also observed that AST and ALT level was higher in mineral supplemented group as compared with the control group. Pandey et al. (2018) and Chaudhary and Patel (2019) observed no significant change in on serum AST concentration due to supplementation of either commercial or ASMM.

Fig. 1 Effect of ASSM on milk yield of Black Bengal does

Table 4 Effect of supplementation of ASSM on different blood parameters

Attributes	Control (T ₀)	Treatment (T ₁)	P
NEFA (μmol/L)	0.28±0.02	0.26±0.02	>0.05
α-amino nitrogen (mg/dl)	37.74±0.77	39.89±1.07	>0.05
Glucose (g/dl)	53.26±1.33	55.70±1.43	>0.05
ALT (IU/L)	29.73±0.74	30.92±0.55	>0.05
AST (IU/L)	127.05±1.27 ^b	132.73±1.26 ^a	<0.05
Calcium (mg/dL)	7.83±0.08 ^b	8.19±0.08 ^a	<0.05
Phosphorus (mg/dL)	4.72±0.17	4.96±0.21	>0.05
Copper (ppm)	0.66±0.02 ^b	0.94±0.02 ^a	<0.05
Zinc (ppm)	0.69±0.01 ^b	0.97±0.02 ^a	<0.05

a.b values bearing different superscripts in column differ significantly ($P < 0.05$) from each other

Effect of area-specific mineral mixture on plasma mineral profile

The overall mean value Ca was higher ($P < 0.05$) in the T1 group (Table 4). This might be because, vitamin D in the intestinal mucosa as 1, 25- dihydroxycholecalciferol acted by the opening of Ca channel and facilitates Ca uptake and transfer with the help of Ca binding protein (Hurwitz, 1990). Phosphorus concentration was found to be similar in both groups. The overall mean of copper (Cu) and zinc (Zn) differed significantly ($P < 0.05$; Table 4) between the groups due to supplementation of ASSM which contains these minerals. Similar results were supported by other workers (Upadhyay, 2004; Chaudhary and Patel 2019; Niaz et al. 2017; Agrawalla et al. 2017 and Samanta et al. 2005).

Conclusions

It is concluded that supplementation of area-specific mineral mixture significantly improved the Ca, Zn and Cu concentration in plasma of Black Bengal does. Though supplementation of ASSM did not have significant improvement in milk production and its composition, more studies need to be carried out to see

the effect of supplementation of the area-specific mineral mixture on the overall performance of goats.

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