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Effect of Area Specific Mineral Supplementation on Growth and Reproductive Performance of Female Black Bengal Goats

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ABSTRACT

To find out the effect of area specific mineral supplementation (ASMS), 24 female Black Bengal goatling were divided into four groups (Gr.I, II, III & IV) which were supplemented with 0, 1, 2% deficient minerals and 2% commercial mineral mixture, respectively. Body weight (BW) was recorded in specific time span. Study revealed that final body weight as well as average daily gain (ADG) in three months significantly ($P<0.05$) differed from control and treatment group. Among treatment groups, better body weight gain was observed in higher mineral supplemented group but was not significant. But, interestingly, the overall body condition score (BCS) differed significantly ($P<0.05$) between control and treatment as well as within treatment group. Age at maturity of control and treatment groups were 222.50 ± 5.74,207.50 ±8.92, 187.50 ± 5.12 and 192.50 ± 6.29 days, respectively and the difference was significantly varied. *Mean oestrogen* and progesterone level was marginally high in mineral supplemented group than control group.

Keywords: Age at first heat, Area specific mineral, Body condition score, Black Bengal goat

The Black Bengal goat (Capra hircus bengalensis), the most common breed in the Eastern and North-Eastern region of India, is a dwarf meat type highly prolific breed of goat. It has also several desirable characters like early sexual maturity (6-8 months) and can be bred round the year. Micro-minerals have a great impact on animal's productive and reproductive physiology and its imbalance causes various problems leading to lowered reproductive efficiency and resultant monetary loss. Health and production of livestock is greatly influenced by optimal level of these essential mineral (Sharma *et al.* 2009). Adequate micro-minerals supplementation is required as most of the roughages, greens, concentrates are deficient in trace mineral elements. Correcting an imbalance in mineral levels can improve reproductive performance and health with little additional cost (Kumar *et al.* 2011). Micronutrient deficient can alter the serum progesterone and estrogen level in animals (Kumar *et al.* 2005). Concept of area specific mineral supplement is a new approach of low input and high output for the end users. Therefore, there is an ample scope for exploiting the concept of area specific mineral supplementation for balancing the deficiency essential for the exploitation of optimum production potential of farm animals. Study report revealed that six minerals are deficient in lower Gangetic part of West Bengal which are Ca, P, Zn, Co and Mn (Ghosh *et al.* 2013). Keeping these in view, the present study was undertaken to find the effect of area specific mineral supplementation on *growth and reproductive performance* of female Black Bengal goat.

MATERIALS AND METHODS

The study was carried out on 24 Black Bengal goatling of 4-5 months of age and maintained at goat unit, IVRI, ERS at Kalyani, Nadia, West Bengal. The farm is located at an altitude of 11 M above the mean sea level, at latitude of 22°98’ North and at longitude of 88°44’ East. The place situated in lower Gangetic plain region of India, Sastry (1995). Animals were randomly divided into four groups on basis of initial body weight. Group I was kept as control. Measured quantity of concentrate feed offered each animal individually without any mineral supplementation. There were three treatment groups i.e. Group II, Group III and Group IV. Concentrate feeds for Group II and Group III were fortified with 1 and 2% area specific mineral supplementation. Whereas, concentrate feed for Group IVwas prepared with same ingredients incorporating commercial mineral mixture @ 2%. Animals were fed individually with 100 g concentrated feed per animals per day. Concentrate feed was offered in the morning hours and thereafter, animals were send for grazing for a period of 6-8 hours. Vaccination and deworming schedule followed in experimental animals were as per standard schedule. Animals were maintained under semi-intensive system. In night time, animals were kept in pucca house and floors are made up of concrete. Each group was kept in separate shed, and in each shed there was ample supply of water for animals. This schedule was followed till the end of experiment. All the animals were weighed empty stomach at fortnight interval so that growth performance as well as ADG can be calculated/determined. Body condition score (BCS) was performed in goats using a BCS ranging from 1.0 to 5.0 according to Villaquiran *et al.* (2004). All animals were observed for onset of puberty (first estrum) by observing the visual signs of oestrus and also using teaser buck for detection of oestrus daily in morning and evening. Necessary blood samples were collected from jugular vein in heparin coated vial at monthly interval from each animal. Estrogen and progesterone were estimated by using commercially available ELISA Kit. Different statistical designs were considered to analysis of data as per Snedecor and Cochran (1994) and analysis through SPSS programme. Mean values and standard error has been derived using one-way ANOVA with Duncan test.

RESULTS AND DISCUSSION

Body weight and ADG of different groups has been presented in table 1 and table 2, respectively. Mean body weight gain over the period of 90 days, in Group I, Group II, Group III, and Group IV was 3.92±0.15, 5.50±0.32, 6.00±0.41 and 6.08±0.20 kg, respectively and the body weight gain differed significantly ($P<0.05$) between treatment and control group. But between treatment groups, the difference was not significant. Of course, there was the good enhancement in body weight gain between 1 and 2% mineral supplementation in feed. Whereas, slender variation was found between 2% mineral supplementation group (Group III) and commercial mineral mixture supplemented the group (Group IV). Similar trend was noticed in ADG. Effect of mineral mixture supplementation on growth performance and ADG was reported by other investigators which is at par with present finding (Yadav *et al.* 2010 and Tiwari *et al.* 2012). The present study revealed that supplementation of only deficient minerals could perform almost similar with commercial mineral mixture supplementation. The cost of commercial mineral mixture is many folds higher than area specific mineral supplements. Body weight gain and ADG were higher in mineral supplemented groups than control this might be due to minerals played role in efficient nutrient utilization.

At beginning of the experiment BCS in Group I, Group II, Group III and Group IV was 1.83±0.17, 1.83±0.17, 1.83±0.17 and 2.00±0.26, respectively. BCS at end of experiment in Group I, Group II, Group III and Group IV was 2.17±0.17, 2.50±0.22, 3.50±0.22 and 3.50±0.22, respectively. Mean BCS in Group I, Group II, Group III, and Group IV was 2.00±0.14, 2.17±0.14, 2.67±0.14 and 2.75±0.14, respectively. Mean BCS differed significantly ($P<0.05$) in different groups. BCS in Group I and Group II differed significantly from Group III and IV. Among treatment groups highest BCS was observed in Group IV followed by Group III, Group II and Group I. Similar to our findings higher BCS was also observed in mineral supplemented group in Malpura ewes (Sejian *et al.* 2012). Spahr (2004) and Villaquiran *et al.* (2005) recommend a BCS of 3.0 to 3.5 as optimal for goats. Lower than the optimum value of BCS was obtained in our study for group I and group II might reflects the effect of mineral deficiency in their ration.

Average age at first heat in Group I, Group II, Group III and Group IV was 222.50±5.74, 207.50 ±8.92, 187.50±5.12 and 192.50±6.29 days, respectively. Age at first heat differed significantly ($P<0.05$) in different groups. Age at first heat observed was earliest in Group III followed by Group IV, Group II and Group I. Essential minerals played

Table 1. Effect of ASMS on body weight (kg) in goats (Mean ± SE)

Treatment	Initial body weight	15 Day	30 Day	45 Day	60 Day	75 Day	90Day	Final body weight gain
Group I (0% ASMS)	6.33 ± 0.36^{a}	6.90 ± 0.36^{a}	7.57 ± 0.31^{a}	8.17 ± 0.33^{a}	8.75 ± 0.38^{a}	9.50 ± 0.36^{a}	10.25 ± 0.33^{a}	3.92 ± 0.15^{a}
Group II (1% ASMS)	6.33 ± 0.51^{a}	6.83 ± 0.46^{a}	7.42 ± 0.57^{a}	8.23 ± 0.51^{a}	10.5 ± 0.55^{b}	11.08 ± 0.61^{ab}	11.83 ± 0.67^{ab}	5.50 ± 0.32^{b}
Group III (2% ASMS)	6.33 ± 0.42^{a}	7.00 ± 0.52^{a}	7.67 ± 0.68^{a}	8.47 ± 074^{a}	10.33 ± 0.67^{ab}	11.08 ± 0.69^{ab}	12.33 ± .071^{b}	6.00 ± 0.41^{b}
Group IV (2% MM)	6.33 ± 0.42^{a}	7.25 ± 0.42^{a}	8.08 ± 0.49^{a}	9.13 ± 0.56^{a}	10.80 ± 0.61^{b}	11.67 ± 0.61^{b}	12.40 ± 0.45^{b}	6.08 ± 0.20^{b}

Values bearing different superscripts in column differed significantly (0 < 0.05) from each other.

Table 2. Effect of ASMS on ADG (g/day) in goats (Mean ± SE)

Treatment	1st (0-15 DAY)	2nd (15-30day)	3rd (30-45day)	4th (45-60 day)	5th (60-75 day)	6th (75-90day)	Mean ADG
Group I (0% ASMS)	90.84 ± 15.36^{a}	100.93 ± 20.78^{a}	79.69 ± 10.36^{a}	71.04 ± 8.34^{a}	88.71 ± 27.04^{a}	80.29 ± 13.06^{a}	43.52 ± 1.71^{a}
Group II (1% ASMS)	85.04 ± 22.17^{a}	82.12 ± 20.69^{a}	117.55 ± 43.76^{a}	287.12 ± 49.67^{b}	55.23 ± 15.56^{a}	67.52 ± 9.31^{a}	61.11 ± 3.51^{b}
Group III (2% ASMS)	102.97 ± 10.39^{a}	90.56 ± 24.76^{a}	104.96 ± 11.79^{a}	234.56 ± 44.90^{b}	74.42 ± 23.35^{a}	114.73 ± 19.05^{a}	66.67 ± 4.55^{b}
Group IV (2% MM)	158.43 ± 51.93^{a}	111.27 ± 30.69^{a}	130.16 ± 16.33^{a}	191.66 ± 43.72^{b}	81.44 ± 39.27^{a}	69.29 ± 15.51^{a}	67.59 ± 2.33^{b}

Values bearing different superscripts in column differed significantly (0 < 0.05) from each other

significant role in onset of puberty. Animals are deficient in essential minerals like Ca, P, Zn, Cu, Co and Mn in the present study area. Therefore, the onset of puberty in mineral supplemented group was significantly earlier than the control group. Our findings are similar to the reports of Koley and Biswas (2004) who reported that mineral supplementation decreased days to first service. Cromwell *et al.* (1997) also reported that delayed sexual maturity when phosphorus intakes were low. Copper along with Cobalt deficiency delayed onset of puberty (Nix, 2002). In general, low fertility associated with delayed or suppressed oestrus commonly found in Cu deficient animals (Smith and Akinbamijo, 2000; Underwood and Suttle, 2003). It was also observed that body weight gain and BCS was much better in Group III and IV which might be the reason for early occurrence of sexual manifestation. Many studies revealed that BCS has significant effect on reproductive performance of cows, sheep and goats. (Molina *et al.* 1994; Atti *et al.* 2001; Mellado *et al.* 2006; Abdel-Mageed, 2009; Madani *et al.* 2009; Sejian *et al.* 2010).

Details of estrogen and progesterone level in different groups has been presented in table 4. Mean estrogen level in Group I, Group II, Group III and Group IV was 20.38±2.36, 24.40±3.96, 27.98±4.74 and 22.46±2.88 pg/ml, respectively. Mean estrogen level also did not differed significantly (P<0.05) in groups. Among treatment groups highest estrogen level in blood was observed in Group III followed by Group II, Group IV and Group I. These findings are in agreement with Devasenat *et al.* (2010)

Table 3. Effect of ASMS on plasma progesterone (ng/ml) and estrogen (pg/ml) in goats (Mean ± SE)

Treatment	0 Day	30 Day	60 Day	90 Day	Mean
			Progesterone level		
Group I (0% ASMS)	0.46 ± 0.09[a]	0.68 ± 0.04[a]	0.71 ± 0.35[a]	1.13 ± 0.11[a]	0.74 ± 0.06[a]
Group II (1% ASMS)	0.52 ± 0.11[ab]	0.58 ± 0.14[a]	0.94 ± 0.14[a]	1.66 ± 0.11[b]	0.92 ± 0.11[bc]
Group III (2% ASMS)	0.47 ± 0.10[ab]	0.70 ± 0.06[a]	0.75 ± 0.05[a]	1.21 ± 0.13[a]	0.78 ± 0.07[ab]
Group IV (2% MM)	0.75 ± 0.08[b]	0.73 ± 0.08[a]	0.72 ± 0.15[a]	1.72 ± 0.12[b]	0.97 ± 0.10[c]
			Estrogen level		
Group I (0% ASMS)	29.62 ± 2.76[a]	20.59 ± 5.61[a]	13.63 ± 2.05[a]	17.66 ± 5.62[a]	20.38 ± 2.36[a]
Group II (1% ASMS)	21.66 ± 7.41[a]	33.00 ± 10.74[a]	23.42 ± 7.06[ab]	19.52 ± 6.88[a]	24.40 ± 3.96[a]
Group III (2% ASMS)	20.75 ± 12.77[a]	20.69 ± 6.23[a]	40.16 ± 11.61[b]	30.33 ± 5.02[a]	27.98 ± 4.74[a]
Group IV (2% MM)	32.21 ± 3.39[a]	23.35 ± 7.15[a]	15.13 ± 3.2[a]	19.16 ± 6.88[a]	22.46 ± 2.88[a]

Values bearing different superscripts in column differed significantly (0 < 0.05) from each other.

who observed that estrogen level was higher in mineral supplemented crossbred cattle compared with control group. Mean progesterone level in Group I, Group II, Group III and Group IV was 0.74±0.06, 0.92±0.11, 0.78±0.07 and 0.97±0.10 ng/ml, respectively. Mean progesterone level differed significantly ($P<0.05$) in different groups. Among groups highest progesterone level in blood was observed in Group IV followed by Group II, Group III and Group I. These findings are in agreement with Devasenat *et al.* (2010) who observed that progesterone level was higher in mineral supplemented crossbred cattle compared with control group. Plasma estrogen and progesterone level were lower in control compared to treatment groups, this might be due to lowered steroidogenesis associated with altered enzymatic activity due to lowerplasma micro-minerals concentration.

CONCLUSION

It is clearly evident from the present study that only deficient mineral if supplemented along with regular feeds would bring about similar effects like commercially available mineral mixture. Supplementation had beneficial effects on growth performance, body condition and puberty of female goats under semi-intensive rearing system. Estrogen and progesterone also found to be at desired level with mineral supplemented group. However, further studies are needed to explore the effect on pregnancy, multiple birth, survival of kids, carcass characteristics, male sexual performance, semen characteristics, milk production and postpartum initiation of estrus.

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