Original Research

Macro and Micro Mineral Deficiency in Goats in Arid Zone of Rajasthan

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Abstract

A study was carried out to evaluate the prevalence of macro and micro-mineral deficiency in goats in and around Bikaner region. For this purpose, 350 blood samples belonging to different physiological stages of goats were collected at random from various locations, following standard sampling procedure. Blood samples were analyzed for determination of haemoglobin, packed cell volume, total erythrocyte count, total leukocyte count and differential leukocyte count as per method of Jain (1986). Biochemical analysis of serum samples was done to estimate total serum protein, albumin, blood glucose, aspartate aminotransferase, alanine aminotransferase, alkaline phosphatase, blood urea nitrogen and creatinine by the IDEXX VetTest Chemistry Analyzer using test kits supplied by IDEXX Laboratories, as per the manufacturers subscribed procedure. Serum globulin was estimated in g/dl as a difference between total protein and albumin. Albumin and Globulin ratio (A:G) was derived after dividing concentration of Albumin by concentration of Globulin in g/dl. Urea was calculated by multiplying blood urea nitrogen (mg/dl) values with factor 2.14. All the samples were processed and analyzed for macro and micro minerals using Inductively Coupled Plasma-Optical Emission Spectrometer (Thermo Fisher Scientific Inc, iCAP 7000 Series). The results revealed adequate sodium, potassium, cobalt and manganese in goats of Bikaner region, irrespective of physiological stages. The overall prevalence of serum calcium, phosphorus, magnesium, copper, iron and zinc deficiency in goats was 22.85, 14.85, 8.28, 37.14, 4.85 and 28.57 per cent, respectively. Wide spread deficiency of copper followed by zinc, calcium and phosphorus and marginal deficiency of magnesium and iron were observed in goats of Bikaner region. From the study, it was apparent that the mineral requirements of goats are not being met by the forages and therefore, it is necessary to supplement these mineral efficiently through region specific mineral supplements in the ration of goats for improving health and productivity.

Key words: Goat, Macro, Micro, Minerals, Serum, Prevalence

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Introduction

Health and production of livestock is greatly influenced by optimal level of major and trace minerals in the body (Sharma *et al.,* 2009). If there is some imbalance between these minerals either due to deficiency or interaction, the animal suffers from poor health, fertility, immunity ultimately affecting its production. Mineral deficiencies, likely to affect production or reproduction include those of the major elements such as calcium, phosphorus, magnesium, sodium, potassium and the trace elements like zinc, copper, cobalt, iron, and manganese (Judson *et al.*,1987). Symptoms of mineral disorders are often non–specific and in case of marginal deficiencies may go unnoticed. Sub-clinical mineral deficiency that affects growth and production is more dangerous than manifested mineral deficiency showing clinical symptoms as it can be corrected (Lengarite *et al.*, 2012). The circulatory level of mineral may be taken as an index for detecting the adequacy or deficiency of such minerals in goats (Jain *et al.*, 2000). Status of macro and micro mineral deficiency in different states, districts and blocks of India as well as abroad has been studied and evaluated by many researchers. (Sharma *et al.*, 2003; Bhooshan *et al.*, 2010; Dar *et al.*, 2014; Bhausaheb *et al.*, 2014a & b; Schweinzer *et al.*, 2017). Mineral deficiency in animals is an area specific problem and such study was lacking in Bikaner, where small ruminants particularly goat form an important part of rural economy. Therefore, the present investigation was carried out to evaluate the prevalence of macro and micro-mineral deficiency in goats in and around Bikaner region.

Materials and Methods

A total of 350 goats belonging to different physiological stages *viz*. young (<5 months), dry, pregnant (above two month of pregnancy), lactating (mid lactation) and bucks (>1 year) under organized and unorganized management conditions were included in the study, which were brought to the Medicine Clinic of Department of Clinical Veterinary Medicine, Ethics and Jurisprudence, CVAS, Bikaner and belonged to private farms or individual holdings of the owner in and around Bikaner. Routine faecal examination was carried out for each animal to rule out the possibility of endo-parasitic load by direct smear, floatation and sedimentation method. The positive cases having parasitic load were excluded from the study. Two hundred blood samples of goats showing symptoms of clinical diseases *viz.* ruminal acidosis, anaemia, debility, enteritis, pica, polioencephalomalacia, simple indigestion were collected from Medicine Clinic of CVAS, Bikaner and designated as Group-I. Similarly, 150 blood samples of apparently healthy goats of different physiological stages *viz.* young, dry, pregnant, lactating and bucks without any sign of clinical diseases were also collected to draw a picture with respect to their mineral status. This group is designated as healthy unorganized group i.e. Group-II. In this group, samples were collected from the Gadwala, Pemasar, Udasar, Udramsar, Shivbari, Kanasar, Karmisar and Sujandesar villages of Bikaner as well as organized and unorganized individual holdings of goats in and around Bikaner.

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Blood samples were collected from jugular vein with all aseptic precautions in sterilized test tubes without any anticoagulant for harvesting serum. The blood slants were made and incubated for 1 hour at 37°C. Blood clots were broken and tubes were centrifuged at 2500 rpm for 30 min. The serum was pipetted out in small pyrex tubes and was kept immediately in the deep freeze at -20°C till further analysis. All the samples were processed and analyzed for calcium, phosphorus, magnesium, copper, iron, cobalt, zinc and manganese using Inductively Coupled Plasma-Optical Emission Spectrometer (Thermo Fisher Scientific Inc, iCAP 7000 Series). Sodium and potassium were estimated colorimetrically by the modified method of Trinder (1960) with standard kits. Serum samples were digested as per the procedure described by Kolmer *et al.* (1951). The data were analysed statistically as per Snedecor and Cochran (1994). The word "critical level" is used in this paper to note a concentration of minerals in serum below which are considered to be deficient (McDowell, 1985).

Results and Discussion

Critical levels of serum minerals were used to determine mineral deficiency status in this study and if concentrations fall below critical levels, goats were considered to be deficient. Circulating blood level of calcium in small ruminants has been very well documented. Level of calcium in goats was ranged between 9-11 mg/dl. Looking to the critical level of 8 mg/dl (McDowell, 1985), the samples below this level was found deficient in calcium in goats. McDowell (1985) also reported that phosphorus levels constantly below 4.5 mg/dl are indicative of phosphorus deficiency. Serum magnesium is another important indicator of mineral status and goats with a serum magnesium concentration lower than 2.0 mg/dl were considered deficient. Serum sodium critical level suggested by Underwood and Suttle (2001) was 285.06 mg/dl. Potassium deficiency may be difficult to determine using serum potassium; however, critical levels have been reported at 9.75 mg/dl (Underwood and Suttle, 2001). A concentration of 0.65 ppm has been recommended as a critical level for serum copper in goat by McDowell (1985). The critical level for cobalt is 0.03 ppm. Besides, McDowell (2003) suggested that serum ferritin is an early indicator of iron deficiency and serum levels can be declined to 1.1 ppm without showing any signs of deficiency in goats. Similarly, early stages of zinc deficiency can be evaluated by determining serum zinc level below the critical level of 0.80 ppm (McDowell, 1985). In addition, serum manganese level lower than 0.20 ppm is indicative of manganese deficiency.

The prevalence percentages of serum mineral deficiency in different physiological stages of goats in and around Bikaner have been presented in Table 1 and 2. The prevalence of serum calcium deficiency in Group-I was 26.00% with highest in lactating goats (47.50%) followed by pregnant goat (37.50%), dry goat (27.50%), bucks (10.00%) and lowest in young goats (7.5%) amongst different physiological stages. The prevalence percentage of serum calcium deficiency in Group-II i.e. healthy unorganized goats was observed

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to be 18.66% with highest in lactating goats (33.33%) followed by dry goats (26.66%), pregnant goats (23.33%), young goats (6.66%) and lowest in bucks (3.33%) amongst different physiological stages (Table 1).

Table 1: Macro-minerals deficiency in goats in and around Bikaner

Minerals	Groups	Physiological Stages					
		Young	Dry	Pregnant	Lactating	Bucks	Overall
Calcium Critical level (8.0 mg/dl)	Gr- I	3/40= 7.5%	11/40= 27.5%	15/40= 37.5%	19/40= 47.5%	4/40= 10%	52/200=26%
	Gr- II	2/30=6.66%	8/30=26.66%	7/30=23.33%	10/30=33.33%	1/30=3.33	28/150=18.66%
	Overall	**5/70=7.14%**	**19/70=27.14%**	**22/70=31.42%**	**29/70=41.42%**	**5/70=7.14%**	**80/350=22.85%**
Phosphorus Critical level (4.5 mg/dl)	Gr- I	3/40=7.5%	8/40=20%	17/40=42.5%	6/40=15%	2/40=5%	36/200=18%
	Gr- II	0/30=0%	4/30=13.33%	7/30=23.33%	5/30=16.66%	0/30=0%	16/150= 10.66%
	Overall	**3/70=4.28%**	**12/70=17.14%**	**24/70=34.28%**	**11/70=15.71%**	**2/70=2.85%**	**52/350=14.85%**
Magnesium Critical level (2.0 mg/dl)	Gr- I	3/40=7.5%	5/40=12.5%	2/40=5%	4/40=10%	0/40=0%	14/200=7%
	Gr- II	3/30=10%	4/30=13.33%	3/30=10%	4/30=13.33%	1/30=3.33%	15/150=10%
	Overall	**6/70=8.57%**	**9/70=12.85%**	**5/70=7.14%**	**8/70=11.42%**	**1/70=1.42%**	**29/350=8.28%**

Critical level for ruminants (McDowell, 1985)

The overall prevalence percentage of serum calcium deficiency in Bikaner region was observed to be 22.85 per cent and needs its supplementation in diet through mineral mixture. Out of 350 blood samples of goats, 80 samples were found to have calcium concentration below the critical level of 8 mg/dl. Among the different physiological stages, the calcium deficient samples was observed highest in lactating goats (41.42%) followed by pregnant goats (31.42%), dry goats (27.14%) with similar values in bucks (7.14%) and young goats (7.14%). The prevalence of serum phosphorus deficiency in Group-I amongst different physiological stages was 18.00 per cent with highest in pregnant goats (42.50%) followed by dry goats (20.00%), lactating goats (15.00%), young goats (7.5%) and lowest in bucks (5.00%). The prevalence percentage of serum phosphorus deficiency in healthy unorganized goats i.e. Group-II was observed to be 10.66 per cent with highest in pregnant goats (23.33%) followed by lactating goats (16.66%) and dry goats (13.33%). No blood sample was found deficient in phosphorus in young goats and bucks in the healthy unorganized groups (Table 1).

The overall blood samples found to be deficient in phosphorus in different physiological stages of goats were young (4.28%), dry (17.14%), pregnant (34.28%), lactating (15.71%) and bucks (2.85%). Out of 350 blood samples of goats, 52 samples were found to have phosphorus concentration below the critical level of 4.5 mg/dl. The overall samples found to be deficient in phosphorus in study area were 14.85 per cent and needs supplementation through mineral mixture. The prevalence of serum magnesium deficiency in Group-I was 7.00 per cent with highest in dry goats (12.50%) followed by lactating goats (10.00%), young goats (7.50%) and lowest in pregnant goats (5.00%) amongst different physiological stages. No blood sample of

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bucks was found deficient in magnesium in Group-I. The prevalence percentage of serum magnesium deficiency in Group-II i.e. healthy unorganized goats was observed to be 10.00 per cent with highest in dry and lactating goats (13.33%) followed by young (10.00%) and pregnant goats (10.00%) and lowest in bucks (3.33%) amongst different physiological stages (Table 1).

The overall prevalence percentage of serum magnesium deficiency was observed to be 8.28 per cent. Out of 350 blood samples of goats, only 29 samples were found to have magnesium concentration below the critical level of 2 mg/dl. Amongst different physiological stages, the magnesium deficient samples were observed to be highest in dry goats (12.85%) followed by lactating (11.42%), young (8.57%), pregnant (7.14%) and lowest in bucks (1.42%). The prevalence of serum copper deficiency in Group-I amongst different physiological stages was 37.50 per cent with highest in pregnant goats (52.00%) followed by dry goats (37.50%), lactating goats (35.00%), bucks (32.50%) and lowest in young goats (30.00%). The prevalence percentage of serum copper deficiency in healthy unorganized goats i.e. Group-II was observed to be 36.66 per cent with highest in pregnant goats (50.00%) followed by lactating goats (36.66%), dry goats (36.66%), young goats (50.00%) and lowest in bucks (26.66%) among the different physiological stages (Table 2).

Table 2: Micro-minerals deficiency in goats in and around Bikaner

Minerals	Groups	Physiological Stages					
		Young	Dry	Pregnant	Lactating	Bucks	Overall
Copper Critical level (0.65 ppm)	Gr- I	12/40= 30%	15/40= 37.5%	21/40=52%	14/40=35%	13/40= 32.50%	75/200=37.5%
	Gr- II	10/30=33.33%	11/30=36.66%	15/30=50%	11/30=36.66%	8/30=26.66%	55/150=36.66%
	Overall	**22/70=31.42%**	**26/70=37.14%**	**36/70=51.42%**	**25/70=35.71%**	**21/70=30%**	**130/350=37.14 %**
Iron Critical level (1.1 ppm)	Gr - I	3/40=7.5%	2/40=5%	5/40=12.5%	3/40=7.5%	0/40=0%	13/200=6.5%
	Gr- II	2/30=6.66%	0/30=0%	1/30=3.33%	1/30=3.33%	0/30=0%	4/150=2.66%
	Overall	**5/70=7.14%**	**2/70= 2.85%**	**6/70=8.57%**	**4/70=5.71%**	**0/70=0%**	**17/350=4.85%**
Zinc Critical level (0.80 ppm)	Gr - I	13/40=32.5%	12/40=30%	10/40=25%	11/40=27.5%	3/40=7.5%	49/200=24.5%
	Gr - II	11/30=36.66%	10/30=33.33%	13/30=43.33%	10/30=33.33%	7/30=23.33%	51/150=34%
	Overall	**24/70=34.28%**	**22/70=31.42%**	**23/70=32.82%**	**21/70=30%**	**10/70=14.28%**	**100/350=28.57 %**

Critical level for ruminants (McDowell, 1985)

The overall samples found to be deficient in copper in different physiological stages of goats were highest in pregnant (51.42%) followed by dry (37.14%), lactating (35.71%), young (31.42%) and lowest in bucks (30.00%). Out of 350 blood samples of goats, 130 blood samples were found to be deficient having copper concentration below the critical level of 0.65 ppm. The overall percentage of sample deficient in copper were 37.14 per cent and needs supplementation through commercial or area specific mineral mixture. The prevalence of serum iron deficiency in Group-I was 6.50 per cent with highest in pregnant goats (12.50%) followed by lactating goats (7.50%) and young goats (7.50%) and lowest in dry goats (5.00%) amongst

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different physiological stages. No blood sample of bucks was found deficient in iron level in Group-I. The prevalence percentage of serum magnesium deficiency in Group-II i.e. healthy unorganized goats was observed to be only 2.66 per cent with highest in young (6.66%) and similar in pregnant and lactating goats (3.33%). No blood sample was found deficient in iron level in dry goats and bucks of Group-II (Table 2). The overall prevalence percentage of serum iron deficiency was observed to be 4.85 per cent. Only 17 samples were found to have iron concentration below the critical level of 1.1 ppm. Amongst different physiological stages, the iron deficient samples were observed to be highest in pregnant goats (8.57%) followed by young (7.14%), lactating (5.71%) and lowest in dry (2.85%) goats. No blood sample of bucks was found deficient in iron level in the study area. The prevalence of serum zinc deficiency in Group-I amongst different physiological stages was 24.50 per cent with highest in young goats (32.50%) followed by dry goats (30.00%), lactating goats (27.50%), pregnant goats (25.00%) and lowest in bucks (7.50%). The prevalence percentage of serum zinc deficiency in healthy unorganized goats i.e. Group-II was observed to be 34.00 per cent with highest in pregnant goats (43.00%) followed by young goats (36.66%), dry and lactating (30.33%), and lowest in bucks (23.33 %) among different physiological stages (Table 2). The overall samples found to be deficient in zinc in different physiological stages of goats were highest in young (34.28%) followed by pregnant (32.82%), dry (31.42%), lactating (30.00%) and lowest in bucks (14.28%). Out of 350 blood samples of goats, 100 samples were found to be deficient having zinc concentration below the critical level of 0.80 ppm. The overall percentage of sample deficient in zinc was 28.57 per cent.

The data obtained in present investigation revealed adequate sodium, potassium, cobalt and manganese in goats of Bikaner region, irrespective of physiological stages. The overall prevalence of serum calcium, phosphorus, magnesium, copper, iron and zinc deficiency in goats was 22.85, 14.85, 8.28, 37.14, 4.85 and 28.57 per cent, respectively. In the present investigation, highest prevalence of copper deficiency followed by zinc, calcium and phosphorus was observed in goats of Bikaner region. However, marginal deficiency of magnesium and iron were also observed in goats. The low level of calcium, phosphorus, copper and cobalt in goats of this area may be attributed to poor contents of these minerals in feeds and fodders as well as grazing resources (Shinde *et al.*, 2006). McDowell (1997) reported that copper deficiency after phosphorus was found to be an important mineral limitation for grazing goats in tropical regions. Yatoo *et al.* (2013) have also reported higher prevalence of copper followed by zinc, cobalt and iron deficiency in goats and the average prevalence of copper, iron, zinc and cobalt was observed to be 45.71, 40.00, 20.0 and 20.0 per cent respectively.

Similarly, Shinde and Sankhyan (2007) reported marginal deficiency of phosphorus and copper in goats, cattle, buffaloes and sheep reared in humid southern- eastern plains of semi-arid Rajasthan. Sarkar *et al.* (1990) reported significantly lower levels of iron and copper in grazing goats irrespective of parasitism.

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The results obtained in the present study finds full support from the reports of Sharma *et al*. (2010) observed serum calcium, phosphorus, zinc and copper towards lower side of normal critical range in milch buffaloes in semi-arid eastern plane of Rajasthan. Further, Sharma *et al.* (2010) also suggested that the rations of lactating buffaloes in semi-arid region of Rajasthan were imbalanced in terms of minerals particularly calcium, phosphorus, copper and zinc. Likewise Sharma *et al.* (2003) recorded the overall prevalence of serum copper, cobalt, zinc and iron deficiency in buffaloes was 59.2, 19.1, 59.2, and 19.9 per cent respectively.

Bhausaheb *et al.* (2014b) also showed low concentration of plasma copper and zinc among the majority of goats and kids in Chhattisgarh state. Similarly, Dar *et al*. (2014) reported deficiency of calcium, phosphorus, magnesium, copper, zinc and iron in goats of Kashmir valley. Gopinath *et al.* (2014) also recorded the overall prevalence of serum calcium, copper, iron and zinc deficiency in cattle of Kerala and found deficiency of these minerals as 35.0, 46.87, 15.0 and 40.0 per cent, respectively. Jain *et al.* (2000) inferred that under grazing conditions the trace minerals like copper, cobalt and zinc, which are deficient in many forages should be supplemented in the diet to meet the requirement of these minerals for optimum productive and reproductive efficiency of goats.

Conclusion

From the study, it was apparent that the mineral requirement of goats are not being met by the forages and therefore need supplementation of deficient mineral through region specific mineral supplements in the ration of goats for improving health and productivity.

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