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Micro-minerals status in goats of different age in semi-arid region of India*

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ABSTRACT

The Present study was conducted to evaluate and compare blood zinc (Zn), copper (Cu) and cobalt (Co) status of healthy female goats (210: 105 of Barbari breed and 105 of Jamunapari breed) of different ages, managed under semi-intensive system at the institute farm. Blood Zn and Cu concentrations were significantly influenced by the age of goats, while blood Co concentration was significantly affected by breed of goats. In Barbari and Jamunapari goats, Zn level was 5.74 ± 0.73 and 4.26 ± 0.69 ppm, respectively, at birth which further increased to 6.03 ± 0.73 and 4.94 ± 0.69 ppm during 1 month of age. Thereafter it decreased significantly with the advancement of age up to 9–10 months of age in Barbari goats. Zn level was significantly low at pubertal age than pre-pubertal age in Barbari goats, while in Jamunapari goats, Zn level was not different in pre-pubertal, pubertal and post-pubertal ages. In these goats, Cu concentration was low at birth which increased with the advancement of age. While blood Cu concentration was not different at pre-pubertal, pubertal and post-pubertal ages. Blood Co concentration did not change with the advancement of age. Barbari goats have significantly higher blood Co concentration than Jamunapari goats

Key words: Age, Cobalt, Copper, Goat, Zinc

Zinc (Zn), copper (Cu) and cobalt (Co) are micro-minerals essential in multiple enzyme systems. Early deficiency of zinc reduces feed intake, growth rate and feed efficiency (McDowell 2003); and cobalt deficiency impairs energy and protein metabolism and then growth and development of the deficient animal (Kadim *et al.* 2006). However, goats are considered as being more resistant to low levels of dietary cobalt (Mburu *et al.* 1993).

Mineral concentrations in goat blood are different from those of other ruminants such as cattle and sheep (Haenlein 1980), and there is a need to more fully understand its micro-mineral requirements. Breed, age, productivity, physiological state of animal, mineral intake, chemical form of elements and interrelationships with other nutrients, affect mineral requirements and status (NRC 1985, Khan *et al.* 2007). Young animals absorb minerals more efficiently than older animals (McDowell 2003). The objective of the present work was to evaluate and compare micro-minerals status of two breeds of goats of different age groups on the basis of mineral concentrations in blood, so as to form the basis for their optimum growth and fertility.

MATERIALS AND METHODS

Animals and feeding: Healthy indigenous female goats (210: 105 Barbari and 105 Jamunapari goats) of different age groups (Table 1), maintained under semi-intensive system of management at the institute farm, were used in this study. Feeding was done according to NRC (1981). Newly born kids were fed with mother's milk for first 15 days with bottle. Weaning was done at 3 months of age. After weaning, experimental goats were allowed 4–6 h grazing and were stall-fed with dry roughage *ad lib*. For Barbari goats, 200 g to 350 g/animal/day pelleted concentrate mixture with 13% and 69% digestible crude protein (DCP) and total digestible nutrients (TDN) respectively was given from 2 to 3 months of age to 9 to 10 months. An additional 50 g feed per animal was given to Jamunapari goats. The adult goats above 1 year of age were given 400 g concentrate mixture daily. Drinking water was given *ad lib*. The animals were dewormed regularly as per standard health practices.

Analysis of micro-minerals: Blood (5 ml) was collected in nitric acid washed heparinized vials from jugular vein at days 0 (birth), 30, 90, 180, 270–300, 330–360 besides pre-

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pubertal, pubertal and post pubertal (one week after estrus) ages for estimation of Zn, Cu and Co. Blood samples were digested as per AOAC (1984). Blood Zn, Cu and Co were estimated in digested samples using flame atomic absorption spectrophotometer. Element specific hollow cathode lamps were used and analytical quality was maintained by repeated analysis of reference samples. Eight working standards were prepared freshly from stock (Naresh 1997).

Analysis of data: Data obtained was analyzed by using mixed model (MIXMDL PC-2) program with a least square technique for fitting non-orthogonal data and maximum likelihood computer program developed by Harvey (1990). Duncan's multiple range test (DMRT) modified by Kramer (1957) was used for pair-wise comparison among least square means for age within breed, effect to find out any significant difference among them. Correlation Coefficient (R) was carried our in pooled manner by using standard method described by Snedecor and Cochran (1994).

RESULTS AND DISCUSSION

In this study, the overall means of blood zinc (ppm), copper (ppm) and cobalt (ppm) for Barbari and Jamunapari goats irrespective of age were 5.44 ± 0.21 and 5.14 ± 0.20 ppm, 0.92 ± 0.03 and 0.92 ± 0.02 ppm and 0.34 ± 0.02 and 0.26 ± 0.02 ppm, respectively (Table 1). In sheep, the blood plasma concentration of Zn, Cu and Co was 8–12 ppm, 0.7–1.3 ppm and 0.1–0.3 ppm respectively (Radostits *et al.* 2000). Similarly, in adult lactating healthy cow, the Zn, Cu and Co concentration was 8.46 ± 1.10 ppm, 0.62 ppm and 0.40 ± 0.03 ppm respectively (Naresh 1997).

Least square analysis of variance indicated that goat blood Zn concentration was significantly (P<0.01) affected by age (Table 2) but not with breed. Concentrations of Zn fluctuate with age, stress, infections and feed restriction (Kincaid 1999). In Barbari and Jamunapari goats at birth, the Zn levels was 5.74 ± 0.73 and 4.26 ± 0.69 ppm, respectively, which further increased to 6.03 ± 0.73 and 4.94 ± 0.69 ppm (Table 1) during 1 month of age. Thereafter it decreased significantly (P<0.05) with the advancement of age up to 9–10 months of age in Barbari goats. Similarly, plasma Zn concentration decreased significantly with increase in age in Nubian goats (Ahmed *et al.* 2001) and in calves (Kincacid and Hodgson 1989). In Barbari goats, 11–12 months of age, Zn level increased significantly (P<0.05) up to 5.18 ± 0.68. Similarly, in cattle, calves did not carry higher concentration of total body Zn than did mature animals (Akan *et al.* 1991). In Jamunapari goats, Zn level also increased at 11–12 months of age though not significantly. In Barbari goats, the Zn level was significantly (P<0.05) low at pubertal age than pre-pubertal age. While in Jamunapari goats, the Zn level was not different in pre-pubertal, pubertal and post-pubertal age. Similarly, no significant difference between the age groups was found in Assami goats (Bhattacharyya *et al.* 1995) and in Kivircik lambs (Akdogan *et al.* 2000).

In this study, blood Cu concentration was affected significantly by age (P<0.01) but there was no effect of breed and interaction between breed and age on Cu concentration. In present investigation, blood copper concentration increased with the advancement of age which may be due to increasing physiological demands of growth. In Barbari and Jamunapari goats, blood copper concentration was low (Table 1) at birth which increased with the advancement of age and attained highest level at 11 to 12 months of age. The copper concentrations are related to age in sheep (Church 1993), in beef and dairy calves (Puschner *et al.* 2004) and in Sudanese camels (*Camelus dromedarius*) (Mohamed 2004). Ahmed *et al.* (2001) showed that an association exists between age and physiological status of dairy Nubian goats, pregnancy, lactation and concentration of copper and zinc. Plasma copper levels increased significantly in adult compared to young animals. The increase in Cu level with age could be associated with higher concentrations of circulating oestrogens in the

Table 1. Least square mean±SE of zinc (ppm), copper (ppm) and cobalt (ppm) at various ages for Barbari and Jamunapari goats

Age (days)	n	Zinc (ppm)		Copper (ppm)		Cobalt (ppm)	
		Barbari	Jamunapari	Barbari	Jamunapari	Barbari	Jamunapari
Birth	8	5.74^{abc}±0.73	4.26±0.69	0.76±0.1	0.52^{c}±0.08	0.41^{ab}±0.06	0.27±0.07
30	8	6.03^{abc}±0.73	4.94±0.69	0.87±0.10	1.01^{ab}±0.08	0.34^{ab}±0.06	0.27±0.07
90	15	4.51^{c}±0.53	4.67±0.50	0.91±0.07	1.02^{ab}±0.06	0.39^{ab}±0.04	0.21±0.05
180	6	4.29^{c}±0.84	4.89±0.79	0.77±0.12	0.90^{ab}±0.10	0.39^{ab}±0.07	0.26±0.09
270–300	21	4.82^{c}±0.45	4.91±0.42	0.96±0.06	1.03^{ab}±0.05	0.24^{b}±0.05	0.27±0.05
330–360	9	5.18^{abc}±0.68	5.93±0.65	1.08±0.09	1.08^{a}±0.08	0.25^{ab}±0.06	0.26±0.07
Pre-pubertal	14	6.65^{ab}±0.55	5.40±0.65	0.97±0.07	0.85^{b}±0.06	0.22^{b}±0.05	0.23±0.06
Pubertal	12	4.84^{bc}±0.59	5.63±0.56	1.02±0.08	0.92^{ab}±0.07	0.68^{ab}±0.05	0.29±0.06
Post-pubertal	12	6.88^{a}±0.59	5.64±0.56	0.96±0.08	0.93^{ab}±0.07	0.44^{a}±0.05	0.28±0.06
Overall	105	5.44±0.21	5.14±0.20	0.92±0.03	0.92±0.02	0.34±0.02	0.26±0.02

Means marked with different a,b,c (superscript) in a column between ages indicate DMRT significance (P<0.05); n=denotes the no. of observations for each age group of each breed.

mature animals as a consequence of oestrous cycle (Desai *et al.* 1978) and probably for normal functioning of endocrine glands during puberty (Pathak *et al.* 1986). In these goats, blood copper concentration was not different at pre-pubertal, pubertal and post pubertal ages. Contrary to this, blood copper concentration was significantly higher on the day of oestrous than during the other stages of reproduction in Assami goats (Bhattacharyya *et al.* 1995) and in nulliparous heifers (Small *et al.* 1997).

In present study, blood Co concentrations was significantly ($P<0.01$) affected by breed but not with age. Barbari goats have significantly ($P<0.01$) higher blood Co concentration than Jamunapari goats. Zadjali *et al.* (2004) also reported that there are likely genetic differences between breeds of the same species. Co plays a more important role in early growth and development (Kadim *et al.* 2006). In Barbari and Jamunapari goats, Co concentration did not change with advancement of age. Contrary to this, kids in the age group 1–3 months showed significantly ($P<0.05$) lower levels of serum vitamin B_{12} than older animals (Zadjali *et al.* 2004). Robertson (1971) suggested that need of the young animal for serum vitamin B_{12} is greater than that of adults because of their higher metabolic rate. Although in Barbari goats, cobalt level slightly decreased at 9 to 10 months of age and remained low up to pre-pubertal age. At puberty, it again increased (though not significantly). While in Jamunapari goats, it did not show any change with the advancement of age. In young lambs (up to 2 months of age), if weaned early, likewise have a need for dietary vitamin B_{12} (NRC 1985). Cobalt deficiency reduced lamb survival and increased susceptibility to parasitic infection in cattle and sheep (Ferguson *et al.* 1998).

Balanced feeding of Zn, Cu and Co in the diet of indigenous goats is very essential for optimum growth, production and reproduction to achieve maximum output in terms of economic returns as healthy, growing and performing kid which survives, reproduces and produces milk and mutton more economically.

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REFERENCES

Ahmed M M M, Hamed T F M and Barri M E S. 2001. Variation of zinc and copper concentrations in the plasma of Nubian goats according to physiological state. *Small Ruminant Research* **39**: 189–193.

Akan V D, De Bont J, Holm V and Ramawana S S E. 1991. A study of mineral status of cattle in a dairy farm in Sri lanka. *Indian Veterinary Journal* **68**: 371–374.

Akdogan-Kaymaz A, Bakirel U, Cagtay P and Jan H. 2000. The effects of serum IgG and trace elements Copper and Zinc on the developments of Kivircik lambs following colostrums intake. *Veteriner-Fakultesi Dergisi Istanbul* **26**: 475–478.

AOAC. 1984. *Official Methods of Chemical Analysis.* Association of Official Analytic Chemists. pp 444–76. Virginia.

Bhattacharyya B N, Talukdar S C, Baruah R N, Baruah K K Sr, Baruah K K Jr and Baruah A. 1995. Studies on circulatory levels of trace mineral at different reproductive status in goat. *Indian Journal of Animal Reproduction* **16**: 96–98.

Church C D. 1993. *El ruminates: fisiologia digestive ynutricion.* pp. 397–408. (Ed.) Acribia S A Zaragoza, Espana.

Desai M C, Thakkar T P, Ami D R and Janakiraman K. 1978. A note on serum copper levels in relation to reproductive performance in Surti buffaloes. *Indian Journal of Animal Sciences* **47**: 398–409.

Ferguson E G W, Mitchell G B and Mac Pherson A. 1988. Cobalt deficiency and *ostertagia circumcincta* infection in the lambs. *Veterinary Record* **124**: 20.

Haenlein G F W. 1980. Mineral nutrition of goats. *Journal of Dairy Science* **30**: 1729–42.

Harvey W R. 1990. User's Guide for MIXMDL PC-2 version Mixed Model Least–Squares and Maximum Likelihood Computer Program (Mimeo). Ohio State University, Columbus, OH.

Kadim I T, Mahgoub O, AI-Ajmi D, Al-Habsi K R and Johnson E H. 2006. Comparative effects of low levels of dietary cobalt and parenteral injections of vitamin B_{12} on body dimensions in different in different breeds of Omani goats. *Small Ruminant Research* **66**: 244–52.

Khan Z I, Hussain A, Ashraf M, Ashraf M Y and McDowell L R. 2007. Macromineral status of grazing sheep in a semi-arid region of Pakistan. *Small Ruminant Research* **68**: 279–284.

Kincacid R L. 1999. Assessment of trace mineral status of ruminants: A review. *Proceedings of American Society of Animal Science.* www.asas.org/JAS/symposia/proceedings/0930.pdf.

Kincaid R L and Hodgson A S. 1989. Relationship of selenium concentrations in blood of calves to blood selenium of the dam and supplemental selenium. *Journal of Dairy Science* **72**: 259–63.

Kramer C Y. 1957. Extension of multiple range tests to group correlated adjusted means. *Biometrics* **13**: 13–18.

Mburu J N, Kamau J M Z and Badamana M S. 1993. Changes in Serum levels of vitamin B_{12}, feed, live weight and haematological parameters in cobalt deficient small East African goats. *International Journal of Vitamin Nutrition and Research* **63**: 135–39.

McDowell L R. 2003. *Mineral in Animal and Human Nutrition.* 2nd edn, 644 pp. Elsevier Science, Amsterdam.

Mohamed H E. 2004. The zinc and copper content of the plasma of Sudanese camels (*Camelus dromedarius*). *Veterinary Research Communications* **28**: 359–63

Naresh R. 1997. 'Studies on profile of trace and toxic heavy metals in mastitis and ameliorative effects of ascorbic acid therapy.' M.V.Sc. Thesis, IVRI, Izatnagar.

National Research Council (NRC). 1981. *Nutrient Requirement of Domestic Animal.* No. 15 Nutrient requirement of goats. Angora, Dairy and meat goats in temperate and tropical countries. National Academic of Sciences, Washington, D.C.

Osman N I, Johnson E H, AI-Busaidi R M and Suttle N F. 2003. The effects of breed, neonatal age and pregnancy on the plasma copper status of goats in Oman. *Veterinary Research Communications* **27**: 219–29.

Pathak M M, Patel A V and Jankiraman K. 1986. Blood serum copper at different stages of pregnancy in Surti buffalo. *Indian Journal of Animal Sciences* **56**: 1202–04.

Puschner B, Thurmond M C and Choi Y K. 2004. Influence of age and production type on liver copper concentrations in calves. *Journal of Veterinary Diagnosis and Investigation* **16**: 382–87.

Radostits O M, Goy C C, Blood D C and Hinchclig R W. 2000. *Veterinary Medicine: A Textbook the Diseases of Cattle, Sheep, Pigs, Goats and Horses.* W.B. Saunders, London.

Robertson W W. 1971. Cobalt deficiency in ruminants. *Veterinary Record* **89**: 5–12.

Small J A, Charmely E, Rodd A V and Fredeen A H. 1997. Serum mineral concentration in relation to estrus and conception in beef heifers and cows fed conserved forage. *Canadian Journal of Animal Science* **77**: 63–68.

Snedecor G W and Cochran W G. 1994. *Statistical Methods.* 8th edn. Iowa State University Press Ames-Iowa.

Zadjali A A1, Johnson E H and Srikandakuma A. 2004. Serum vitamin B_{12} level in Omani goats. *Tropical Animal Health and Production* **36**: 437–82.