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Effect of supplementation of amino acid chelate of Zn, Cu, Mn and Co heptagluconate on performance of Barbari goat kids

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ABSTRACT

Male Barbari kids (56), 7 to 8 months of age and weighing19.2± 2.9 kg were randomly divided into 4 equal groups to assess the effect of source (inorganic or organic) and level of Zn, Cu, Co and Mn on intake and growth performance. The kids of control group were fed inorganic source of Zn, Cu, Co and Mn while other groups were fed organic complex (Zn, Cu and Mn amino acid and Co as cobalt heptagluconate at 50, 75 and 100 % of inorganic requirement. Feeding cum growth experiment lasted for 105 days. The live weight of kids at initiation of experiment varied from 19.12 to 19.67 kg, and final live weight ranged between 23.4 to 25.01 kg among the four groups. Total gain and average daily gain varied from 4.82 to 5.34 kg and 45.9 to 50.9 g respectively, which were not different among the four groups. The feed intake varied from 3.9 to 4.0 % of live weight. Live weight change remained lower in kids supplemented 75 and 100% organic trace minerals and had a pooled 6.9 and 9.8% lower average daily gain respectively. The feed efficiency and feed conversion ratio was similar among the four groups. Supplementation of 50% organic minerals provided daily gain equal to inorganic supplemented kids, while 75 and 100 % organic supplementation deteriorated daily gain. Therefore, at 50% organic supplementation levels, the bio-availability of Zn, Cu, Co and Mn have met the daily requirement of kids in relation to recommended requirements of inorganic minerals.

Key words: Chelated minerals, Feed efficiency, Feed intake, Goat, Growth

Soil and water pollution of different elements is a problem in several countries including India. At the same time, trace mineral deficiencies have been reported in soil, plants and animals in several parts of the world (Tripathi and Karim 2008). The soil type and rainfall level and patterns affects trace minerals level in plant and grazing resources and thereby in animal body. Studies of soil-plant and animal relationship have demonstrated the wide deficiency of trace minerals in plants and animals in India (Tripathi *et al.* 2001, 2002a). Supplementation of deficient trace minerals has improved the mineral levels in animal body (Tripathi *et al.* 2002b). Several strategies involving top dressing of minerals in the grazing land (Grace 1992, Paik and Kim 1993), and ruminal implant of slow release soluble glass bolus (Kendall *et al.* 2001, Zeravas *et al.* 1998) recommended for correcting the trace minerals deficiency in grazing ruminants. However, feeding of minerals in diet is a common practice under prevailing animal production system around the world including developing countries. Trace minerals are required in a very low quantity but influenced animal metabolism and production at a greater level because these are the component of several enzyme systems or exert catalytic functions in animal body. However, mineral availability in animal system varies greatly depending on source, presence or absence of antagonism and interaction with other trace minerals. The trace minerals utilisation efficiency can be improved by organic source of supplementation by minimizing excretion and this could also reduce pollutants in soil and environment and thus in human food chain, when present in feed and foods at balanced levels.

The physiological advantage of organic trace minerals have offered by the unique chemistry of organic metal complex, which permits highly soluble, chemically stable product that resists interactions with antagonists in the gut (Brown and Zeringue 1994, Spears 1996). The trace minerals present in the animal body and their function occurs almost as organic complexes or chelates and not as free inorganic ions. Trace minerals complexes with organic molecules have been more bio-available than inorganic trace minerals (Brown and Zeringue 1994). The metal complex or chelates can be absorbed as such or can be modified to a chemical form of the mineral that can be absorbed (Spears 1996). Bio-availability of chelated minerals in animal system is higher in comparison to inorganic counter parts and the chelated Cu supplementation has been reported to reduce fecal excretion (Mandal *et al.* 2007). The utilization

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of inorganic trace mineral depends on the ability of the animal to convert them to organically active form, which is governed by several biotic and abiotic factors. The animal feeds naturally contain trace minerals primarily as organic chelates or complexes. The higher bioavailability of organic Cu could be due to the formation of highly soluble and chemically stable products (Brown and Zeringue 1994) that did not affect bio-availability of Zn (Eckert *et al.* 1999). Chelated Cu complexes are absorbed via a mechanism that differs from the one controlling absorption of inorganic Cu, and does not interfere with Zn and Fe absorption (Du *et al.*1996). The Zn, Cu, Co and Mn are the essential and most deficient minerals in animal feeds and feeding. These are essential element for ruminants and their deficiency may reduce appetite causing low growth rate and wool growth (Reis and Sahlu 1994, White *et al.* 1994, Sandoval *et al.* 1997, Jia *et al.* 2008). An interrelationship exits among these trace minerals (Haenlein and Anke 2011). Therefore, present experiment's aim is to assess effect of varying levels of organic trace minerals complex feeding on intake and performance of growing Barbari kids under stall feeding and management.

MATERIALS AND METHODS

Growing male Barbari kids (56) were randomly divided into 4 equal groups. Animals were fed a standard diet for 105 days under stall and penned in well-ventilated enclosures for the experiment. The diets fed to control animals contained inorganic source of minerals, while organic trace minerals complex (containing Zn, Cu and Mn amino acid complex, and Co as Cobalt glucoheptonate) were supplemented in other three groups at 50, 75 or 100% of their inorganic requirement. The concentrate mixture was fed at 15 g/ kg live weight to provide adequate essential nutrient required to support 50 to 100 g daily gain in goat kids (ICAR 1998).

Restricted quantity of green fodder was offered to meet vitamin requirements, while *ad-libitum* dry roughage (gram straw; *Cicer arietinum*) was available to animals in an excess to allow 10 % refusal. The concentrate mixture fed to animals contained barley 0.81, groundnut oil cake meal 0.16, mineral mixture 0.02 and common salt 0.01 in parts. Animals received fresh feed once a day at 9:30 h, after discarding the residue of previous days. Feed records were maintained throughout experiment. Feed sample were collected at weekly intervals for dry matter (DM) determination. Free choice water was available. Animals were dewormed at beginning of the experiment against roundworms, lungworms and fluke.

The feeding cum growth trial lasted for 105 days in a randomized design, during which kids BW were recorded for two consecutive days every 15 days and these values were used to determine BW gain. Pattern of growth was calculated based on these 15 days periods BW change.

Results of feed intake, feed efficiencies, and growth were analyzed using repeated measure analysis, which used following mathematical model as: $Y_{ijkl} = \mu + T_i + P_j + (T_i \times P_j)_k + e_{ijk}$, where Y_{ijkl}, observation mean; μ, general mean; $T_{i,}$ effect of i^{th} treatment (i = 1, 4); $P_{j,}$ effect of j^{th} fortnight of experiment (j, 1, 7); $(T_i \times P_j)_k$, interaction between i^{th} dietary treatment and j^{th} fortnight of growth; e_{ijk}, random error. The Duncan's multiple range tests were used to determine significant levels between pair of observation for four animals groups using SPSS Base 15.0.

RESULTS AND DISCUSSION

The live weight of kids at initiation of experiment increased during experiment and ranged between 23.4 to

Table 1. Feed intake and performance of kids supplemented with organic trace minerals

	Level of organic trace minerals*					Significance (*p-value*)		
							Contrast#	
	0	50	75	100	Treat	SEM	Lin	Quad
Growth performance								
Initial BW (kg)	19.67	19.22	19.13	19.12	0.391	0.955	0.709	0.683
Final BW (kg)	25.01	24.51	24.10	23.4	0.432	0.825	0.735	0.400
Total gain (kg)	5.34	5.29	4.98	4.82	0.195	0.749	0.996	0.296
Average diet gain (g/d)	50.9	50.4	47.4	45.9	1.856	0.749	0.996	0.296
Feed intake								
Concentrate (g/d)	373.2	373.2	373.2	348.3	2.073	<0.001	<0.001	<0.001
Straw (g/d)	328.0	314.8	321.5	310.8	7.137	0.859	0.668	0.727
Green (g/d)	185.86	200.46	186.8	188.6	1.804	0.007	0.692	0.043
Total (g/d)	887.1	876.7	881.4	859.6	8.237	0.694	0.902	0.511
Feed Efficiency								
Feed conversion ratio (kg feed/kg gain)	18.3	18.7	21.3	19.5	0.849	0.625	0.698	0.280
Feed conversion efficiency (%)	5.69	5.76	4.91	5.43	0.266	0.689	0.904	0.323

*Level of organic mineral complex supplementation, #Lin, linear; Quad, quadratic.

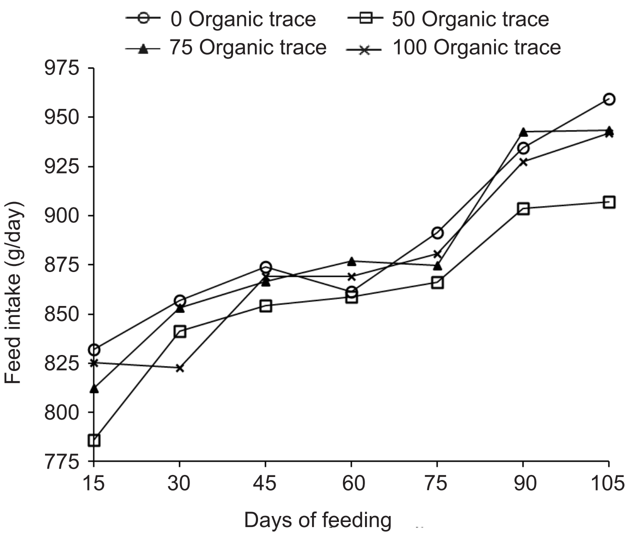

Fig. 1. Feed intake of kids supplemented with multi-organic mineral complex.

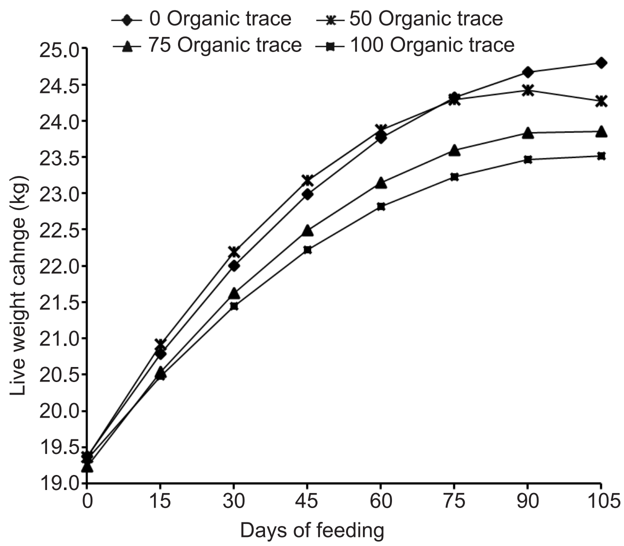

Fig. 2. Live weight change of kids supplemented with multi-organic mineral complex 0 Organic Trace, –0.1077x2 + 1.7446x + 17.734, $R^2 = 0.9811$; 50 Organic trace, –0.1423x2 + 1.9815x + 17.523, $R^2 = 0.9765$; 75 Organic trace, –0.1065x2 + 1.6173x + 17.727, $R^2 = 0.9844$; 100 Organic trace, –0.0911x2 + 1.4161x + 18.012, $R^2 = 0.9586$.

25.01 kg among 4 groups. Similarly, total gain and average daily gain varied from 4.82 to 5.34 kg and 45.9 to 50.9 g respectively (Table 1). The animal in different groups consumed feed varying from 3.9 to 4.0 % of live weight, although feed intake was similar among 4 groups but pattern of intake (Fig. 1) showed that feed intake increased in inorganic trace minerals supplemented kids than occurred in 50 % organic supplemented kids with an equal average daily gain of 50 g. The pattern of live weight change (Fig. 2) of animal revealed that 50 % organic supplemented kids had higher live weight up to 75 days of experimental feeding thereafter it reduced. This depression in live weight gain could be due to lower feed intake of kids in 50 % organic trace complex supplemented kids. Pattern of live weight change remained lower in 75 and 100 % organic trace minerals supplemented kids and had a pooled 6.9 and 9.8 % lower average daily gain respectively. The feed efficiency and feed conversion was lower but similar among 4 kid groups in present experiment could be due to low level of concentrate feeding, however average daily gain remained optimum reported for native Barbari kids (Chaudhary *et al.* 2013, 2015). Supplementation of 50 % organic minerals have provided daily gain similar to inorganic requirement of kids, while 75 and 100 % organic supplementation deteriorated daily gain. Therefore, at 50 % organic supplementation levels bio-availability of Zn, Cu, Co and Mn fulfilled daily requirement of kids, while at 75 and 100 % organic supplementation levels, kids might face mineral imbalance due to higher bioavailability, which impaired metabolism and resulted in reduced daily gain. It was reported that organic sources of trace minerals protected from antagonism and has 31 to 40 % greater bioavailability than inorganic sources (Hansen *et al.* 2008). Based on apparent absorption to tissue and blood concentration, it was suggested that organic trace minerals are considerably better absorbed than inorganic forms (Spears 1996). Copper and Zn were the most limiting minerals in soil and plants of semiarid plains in India (Tripathi *et al.* 2001, Chaudhary *et al.* 2013).

Supplementation of copper is known to promote growth at higher levels (Suttle 2010) but its use in animal feeding is restricted, further the bioavailability of copper is altered by zinc content in diet. Higher dietary zinc levels impair copper absorption and vice versa (McDonald *et al.* 2008), Dietary zinc and copper is known to reduce bioavailability of iron in ruminants and both have antagonism to iron (Suttle 2010). Further, improved bioavailability of copper and zinc in organic minerals supplemented groups reduced bioavailability of iron (Garg *et al.* 2008). Thus, balanced use of trace minerals in animal feeding seems optimum for animal production and the sources having higher bioavailability could be required in reduced amount. Similar to present findings, supplementation of equivalent amount of $CuSO_4$ or copper-proteinate in kids did not improve performance (Mondal *et al.* 2007), and dairy cows supplemented zinc, copper and selenium as carbo-amino chelates did not produce beneficial effects over in organic sources (Cortinhas *et al.* 2010) on levels of superoxide dismutase, glutathione peroxidase and ceruloplasmin. Since higher bioavailability of organic trace minerals complex has been confirmed by several researchers, we hypothesized that organic trace minerals supplementation at lower level than the required inorganic trace minerals may fulfill animal requirement. Experiments with kids (Mondal *et al.* 2007), lambs (Cheng *et al.* 2008), sheep (Luo and Dove 1996), calf (Mulhlenbein *et al.* 2001) and steers (Wanger *et al.* 2008) also did not demonstrate the advantage of feeding trace minerals complexes with amino acids.

Similar feed intake, growth and feed efficiency of kids supplemented 50 % organic mineral mix seems optimum to satisfy trace minerals requirement of kids during active growth phase, thus, present organic mix had 50 % higher bio-availability than inorganic sources. While at higher levels of organic minerals feeding, daily gain may reduce due to minerals imbalance at tissue level.

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