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Effect of Supplementation of Chelated Minerals on Serum Mineral Profile of Buffalo Calves

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A B S T R A C T

Fifteen buffalo calves of average six to ten months old were used to determine the effects of supplementation of chelated minerals on their serum mineral profile. Calves were divided into three groups each having five animals in such a way that mean body weight was similar ($P>0.05$) among the groups. Each group was assigned to one of the following diets as: control diet with conventional mineral mixture (T_1), diet with 50% conventional mineral mixture replace with chelated minerals (T_2) and diet with 100% conventional mineral mixture replace with chelated minerals (T_3). Blood samples were collected aseptically at the beginning of the experiments i.e. day 0, and thereafter at monthly interval periods, during early morning hours before feeding and watering of the animals by jugular vein-puncture. Approximately ten milliliter (ml) of blood was collected from each animal and transferred immediately into a set of sterile plastic tubes without anti-coagulant for serum mineral analysis respectively. It was observed that the serum calcium, phosphorus, copper, zinc, manganese, iron, cobalt concentrations were significantly higher ($P<0.05$) in group T_3 as compared to T_1. The increased level of Cu, Zn, Mn, Co and Fe in the serum of the buffalo calves supplemented with chelated minerals might be due to the higher bio-availability of these elements from chelated as compared to inorganic mineral mixture.

Introduction

Minerals are essential for growth and reproduction and are involved in a large number of digestive, physiological and biosynthetic processes in the body. Animal obtain minerals through the consumption of natural feeds, fodders and supplementation of inorganic salts as mineral mixture in the ration. Minerals are supplied to the livestock through mineral mixture in the inorganic form. One of the major disadvantages of using such supplements is that the minerals from such sources are not fully absorbed due to antagonism and anti-nutritional factors present in the diet. In addition, higher levels of inorganic salt based mineral mixture resulted in increased excretion, which may cause environmental pollution. Therefore, in order to meet the increasing demand of bio-available elements and to reduce the contamination of surface water and soil, the concept of chelated mineral/mineral proteinate came up (Spears, 1989). A chelated mineral is a mineral such as copper, zinc, manganese, cobalt or iron (there are others) that is bonded to "small proteins", peptides or amino acids. The level of chelated minerals in livestock feeding is typically added at 25-30% of the total mineral in a feed (Jackson, 1993). There are several studies in different animal species with different sources of different mineral elements, which have revealed notable differences in the bioavailability of organic and inorganic minerals. Studies suggest that binding of Cu, Zn, Fe and Mn with amino acids and peptides can enhance the bioavailability of these trace minerals, thereby leading to improved milk production, growth, reproduction and general health status in livestock (Pal and Gowda, 2015).

Due to the paucity of the literature on the effect of chelated mineral on the mineral concentration of buffalo calves, the present study has been planned to evaluate the efficacy of chelated mineral mixture on the serum mineral profile of buffalo calves.

Materials and Methods

The experiment was conducted for the period of four months at Buffalo farm, Department of Livestock Production Management, LUVAS, Hisar to study the effect of supplementation of chelated minerals on the growth performance of buffalo calves. The fifteen buffalo calves were randomly distributed into three treatment groups each having five buffalo calves in such a manner that average body weight and age of each experimental group was statistically similar.

In treatment T_1 (control) animals were fed with seasonal green fodder, wheat straw and conventional concentrate mixture throughout the experiment period while treatment T_2 animals were fed similar to T_1 but 50% conventional minerals mixture were replaced by chelated minerals. Likewise in treatment T_3 conventional concentrate mixture was supplemented with 100% chelated minerals per animal per day. The amount of concentrate mixture was given to each group in such a way that the experimental ration remains iso-nitrogenous and iso-caloric. The quantity of different feeds given to each group was adjusted at fortnightly intervals so that the overall DCP requirements of buffalo calves were met according to the change in body weight. Blood samples were collected at the beginning of the experiments and thereafter at monthly interval before feeding and watering of the experimental animals. About ten milliliter (ml) of blood was collected by jugular vein-puncture into a set of sterile plastic tubes without anti-coagulant for serum minerals tests.

Blood collected without anti-coagulant were centrifuged at 2500 to 3000 rpm for 25 minutes and serum was separated and used for estimation of biochemical parameters in serum viz. Serum calcium (mg/dl) and phosphorus (mg/dl) using kits procured from M/S Transasia Biomedical Limited with fully automated Random Access Clinical Chemistry Analyzer (EM 200^{TM} Erba Mannheim – Germany). The serum samples were digested in digestion mixture consisting of nitric acid and perchloric acid for estimation of minerals copper, zinc, and manganese, iron and cobalt using by atomic absorption spectrometer- model Pinaacle 900T, S/N PTAS13050201 of PerkinElmer Company.

Statistical analysis

The data were analyzed statistically using standard methods (Snedecor and Cochran, 1994). The data were expressed as Mean ± SE and were analyzed by one-way ANOVA using general linear model of SPSS version 16 and Duncan's multiple range tests was applied to test the significance. Significance was declared when P value is less than 0.05 (Duncan, 1955).

Chemical composition of the concentrate mixtures (AOAC, 2005)

Chemical composition of the concentrate mixtures of various proximate nutrients and mineral contents has been presented in table 1, 2, 3 and 4.

Results and Discussion

The present study revealed that serum concentrations of Ca and P in treatment group T_3 fed 100% chelated mineral were significantly (P<0.05) higher as compared to control group T_1 fed inorganic mineral mixture. The results of the study indicated that supplementation of chelated minerals in place of inorganic mineral mixture improved the serum calcium and phosphorus concentration in growing calves.

It was further revealed that there was no significant effect (P>0.05) of supplemental trace minerals on serum concentration of Cu, Fe, Mn and Co up to 60 days and zinc up to 30 days. However, day 61 onwards the calves in T_3 group fed 100% chelated mineral exhibited high (P<0.05) serum concentrations of Cu, Mn, Fe and Co as compared to control group T_1 fed inorganic mineral mixture and 31 day onwards zinc concentration in serum became significant (p<0.05) higher in treatment group (T_3) than T_1 group. Present study revealed serum minerals concentration of calves increased linearly with the increase of days due to mineral supplementation and the effect was more pronounced in group supplemented with chelated minerals that was in treatment group T_3. Similar observation was recorded by Olson *et al.,* (1999) who reported that supplementation of trace minerals containing Cu, Mn and Zn in organic and inorganic form raised the serum level of respective minerals compared to the control but within sources only Serum Zn level was found more from organic form than inorganic.

Bhanderi *et al.,* (2008) also reported high (P<0.05) serum concentrations of Cu, Zn and Mn, in male calves fed MBOTMs as compared to control group fed inorganic minerals. Mondal *et al.,* (2008) also found serum mineral concentration of zinc, copper, manganese and iron increased linearly (P<0.05) with the increase of days due to mineral supplementation particularly in organic mineral (T_3 and T_4) supplemented group.

Serum mineral profile of experimental buffalo calves at monthly intervals has been presented in tables 5–11.

Values are means ±standard errors; the values in a row with different superscripts differ significantly between the treatments (P<0.05)

Table.1 Ingredient composition of experimental concentrate mixture (kg)

Ingredient	**T_1**	**T_2**	**T_3**
Maize	15	15	15
Wheat	15	15	15
GNC	25	25	25
Mustard Cake	15	15	15
Wheat Bran	27	27	27
Common salt	1	1	1
Mineral mixture	2	2*	2**
Total	100	100	100

*supplemented @conventional mineral mixture replaced with 50 % chelated minerals
*supplemented @conventional mineral mixture replaced with 100 % chelated minerals

Table.2 Proximate composition (per cent) of concentrate mixture

Treatments	Attribute								
	DM	OM	CP	CF	EE	NFE	TA	NDF	ADF
T_1	89.77	89.3	19.93	6.97	4.12	52.36	10.70	37.44	18.60
T_2	90.01	89.31	19.90	6.92	4.05	52.12	10.69	37.40	18.25
T_3	89.04	89.35	19.80	6.88	4.09	52.26	10.65	37.47	18.44

Table.3 Inorganic and chelated elements composition of different mineral supplement in ration of buffalo calves

Minerals (%)	Inorganic Minerals	Chelated Minerals
Zinc	0.9%	0.9%
Copper	0.4%	0.4%
Manganese	0.35%	0.30%
Cobalt	0.15%	0.15%
Iron	3%	2.8%

Table.4 Chemical composition (%) of whole diet fed to the experimental animals

Ingredients	DM	OM	CP	CF	EE	ASH	NDF	ADF	NFE
Maize	92.20	97.50	9.03	2.65	3.39	2.50	67.70	44.36	82.43
Wheat	91.61	97.77	10.89	2.77	3.15	2.23	23.07	10.12	80.96
Wheat Bran	92.86	93.88	12.00	11.83	1.01	27.07	49.23	16.13	48.09
GNC	92.70	90.00	39.16	8.00	8.30	7.50	19.20	10.12	37.04
Mustard cake	93.46	93.17	34.62	8.33	6.25	6.83	23.50	13.27	43.97
Maize Green	25.00	14.30	7.45	27.00	3.40	10.70	64.87	37.84	51.45
Wheat Straw	90.00	78.00	2.81	35.00	1.05	12.00	74.83	51.90	49.14

Table.5 Serum calcium concentration (mg/dl)

Days	T_1	T_2	T_3
0	8.64±0.27	8.80±0.25	8.66±0.10
30	8.82^{a}±0.24	9.08^{ab}±0.16	9.40^{b}±0.18
60	9.00^{a}±0.22	9.12^{a}±0.82	9.40^{b}±0.18
90	9.44^{a}±0.24	9.84^{a}±0.18	10.7^{b}±0.30
120	9.70^{a}±0.13	10.94^{b}±0.37	11.94^{b}±0.15

Table.6 Serum phosphorus concentration (mg/dl)

Days	T_1	T_2	T_3
0	3.76±0.08	3.90±0.11	3.86±0.15
30	4.00^{a}±0.15	4.50^{b}±0.15	4.66^{b}±0.10
60	4.06^{a}±0.17	4.68^{b}±0.08	4.94^{b}±0.12
90	4.50^{a}±0.13	4.88^{a}±0.48	5.70^{b}±0.20
120	4.86^{a}±0.13	5.10^{a}±0.08	6.04^{b}±0.18

Table.7 Serum copper concentration (mg/l)

Days	T_1	T_2	T_3
0	0.45±0.05	0.48±0.02	0.50±0.05
30	0.56±0.02	0.57±0.18	0.60± 0.01
60	0.61^{a}±0.02	0.69^{ab}±0.49	0.79^{b}±0.05
90	0.74^{a}±0.02	0.85^{ab}±0.06	0.93^{b}±0.05
120	0.87^{a}±0.03	0.96^{ab}±0.02	1.01^{b}±0.05

Table.8 Serum zinc concentration (mg/l)

Days	T_1	T_2	T_3
0	0.38±0.05	0.40±0.04	0.40±0.01
30	0.47^{a}±0.01	0.52^{ab}±0.01	0.55^{b}±0.01
60	0.64^{a}±0.01	0.65^{ab}±0.01	0.68^{b}±0.13
90	0.73^{a}±0.02	0.77^{ab}±0.08	0.81^{b}±0.09
120	0.84^{a}±0.01	0.87^{ab}±0.01	0.90^{b}±0.08

Table.9 Serum manganese concentration (mg/l)

Days	T_1	T_2	T_3
0	0.05±0.00	0.06±0.20	0.06±0.01
30	0.07±0.01	0.07±0.02	0.08±0.02
60	0.08^{a}±0.01	0.09^{ab}±0.02	0.10^{b}±0.05
90	0.12^{a}±0.05	0.14^{ab}±0.06	0.15^{b}±0.05
120	0.14^{a}±0.01	0.15^{ab}±0.08	0.17^{b}±0.04

Table.10 Serum iron concentration (mg/l)

Days	$\mathbf{T_1}$	$\mathbf{T_2}$	$\mathbf{T_3}$
0	0.91±0.02	0.93±0.10	0.92±0.01
30	0.96±0.06	1.00±0.02	1.03±0.04
60	1.10^{a} ±0.03	1.18^{ab}±0.09	1.24^{b}±0.04
90	1.38^{a}±0.03	1.46^{ab}±0.04	1.56^{b}±0.06
120	1.52^{a}±0.03	1.64^{ab}±0.05	1.76^{b}±0.02

Table.11 Serum cobalt concentration (mg/l)

Days	T_1	T_2	T_3
0	0.20±0.05	0.22±0.04	0.22±0.03
30	0.24±0.01	0.28±0.02	0.29±0.02
60	0.30^{a}±0.04	0.32^{ab}±0.02	0.40^{b}±0.03
90	0.35^{a}±0.07	0.42^{ab}±0.02	0.48^{b}±0.03
120	0.43^{a}±0.02	0.57^{b}±0.01	0.65^{b}±0.04

In another study, Engle *et al.,* (2000) who reported higher ($P<0.05$) serum Cu concentration on 84 days due to $CuSO_4$ and Cu-lysine supplementation. Spears (1989) also found enhanced serum Cu level from both sources of $CuSO_4$ and Cu-lysine like the present findings. However in contrary to the present findings Tambe *et al.,* (1998) did not find any improved trace mineral profile on chelated and non-chelated mineral supplementation in calves. Higher serum concentration of trace mineral with organic mineral supplementation probably due to higher absorption and retention in tissue level (Boland 2003).

The results of the study indicated that supplementation of chelated minerals in place of inorganic mineral mixture improved the serum mineral profile in growing calves.

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