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# Effect of Organic Cu and Zn on the Performance of Pre-Ruminant Buffalo Calves

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**A B S T R A C T**

Micro-mineral deficiencies of Zinc, Manganese, Iodine and Copper have been identified in blood plasma and serum levels of livestock in state of Punjab. Eighteen female buffalo calves of 15 day of age were randomly divided into 2 groups of nine each and fed calf starter of ingredient composition as per the prevailing feeding practice at the university dairy farm containing 0.66% zinc and 0.1% copper (organic and inorganic) in the mineral mixture as per specifications along with green fodder and milk. The growth study was of 120 days. Body weight and body measurements were recorded at monthly intervals to calculate growth of calves. Blood samples were collected at the beginning and end of experiment. Results indicated that the physical parameters were similar in $TMR_{IM}$ and $TMR_{OM}$ fed calves. The average daily gain was 462.5 and 537.5 gm in $TMR_{IM}$ and $TMR_{OM}$ respectively, though the difference was non-significant. Results indicated similar total TMR intake but significantly ($P<0.01$) higher digestibility of DM ($P<0.05$), CP ($P<0.01$), EE ($P<0.01$), NDF ($P<0.05$) in $TMR_{OM}$ in comparison to $TMR_{IM}$ fed group. Better digestibility of CP and energy sources led to higher ($P<0.01$) percent DCP and TDN intake. The glucose, and total protein were significantly ($p<0.05$) higher in $TMR_{OM}$ as compared to $TMR_{IM}$. The other blood parameters were similar in both the groups. It may be concluded that buffalo calves fed zinc-lysine and Cu-lysine and inorganic Zn and Cu based TMRs exhibited no difference DMI and body measurements but supplementing organic minerals improved nutrient utilization and daily gain. It may be concluded that use of organic copper and zinc may be beneficial for improving growth, nutrient utilization and health of female buffalo heifers.

## Introduction

Although minerals do not provide energy, they are components of the enzyme system that play an important role in the intermediary metabolism of the major nutrients, immunity, health, production and reproduction. Zinc (Zn) and Copper (Cu) both act by enhancement of pituitary hormone functions. Zinc deficiency results in reduced appetite and depressed growth. Absorption of dietary zinc ranges from 15-60%. Micro-mineral deficiencies of Zinc, Manganese, Iodine and Copper have been identified in blood plasma and serum

levels of livestock in state of Punjab (Randhawa *et al.,* 2009; Randhawa and Randhawa, 2002). In dairy rations, minerals are supplied in inorganic form which may not be absorbed at the level and speed required due to adulteration, poor solubility or interaction with other minerals.

Besides, feed grade salts vary in their mineral concentration due to natural contaminants, basic composition and methodology used in processing (Sunder *et al.,* 2007).

Minerals complexed with organic molecules have shown to resist many of the interactions mentioned above. Chelate comes from the Greek word 'claw' in which a metal atom is held in the complex through more than one point of attachment to the ligand (amino acids or polysaccharides). Organic sources of trace minerals have been found to be more bioavailable than inorganic sources (Huang *et al.,* 2009).

Research indicates that organic minerals are beneficial for improving digestibility of nutrients in kids and buffalo calves (Saijpaul and Sikka, 2012; Gupta, 2014) and maintaining performance of kids under stressful conditions (Chandrahas *et al.,* 2015). Data on long term supplementation of organic minerals like Zn and Cu was limited.

## Materials and Methods

Eighteen female buffalo calves of 15 day of age were randomly divided into 2 groups of nine each and fed calf starter of ingredient composition as per the prevailing feeding practice at the university dairy farm containing 0.66% zinc and 0.1% copper (organic and inorganic) in the mineral mixture as per specifications along with green fodder and milk. The growth study was of 120 days. In between the growth study a digestion-cum-metabolic trial was conducted of 6 days. Two different mineral mixtures (MM) were prepared containing zinc and copper either in organic form as Zn-lysine and Cu-lysine or inorganic form as $ZnSO_4$ and $CuSO_4$. All the chemicals used in the preparation of mineral mixture were laboratory grade.

The organic and inorganic Zn and Cu used in the preparation were assessed for zinc and copper by atomic absorption spectrophotometer (AAS) before formulating the MM. Accordingly, the MM were formulated as per the experimental design. The ingredient composition of the mineral mixtures has been given in Table 1 for organic ($MM_{OM}$) group and inorganic ($MM_{IM}$) group.

Body weight and body measurements were recorded at monthly intervals to calculate growth of calves. Blood samples were collected at the beginning and end of experiment for biochemical parameters as per standard methodology.

Feed, fodder, residue and feces: Chemical composition (AOAC 2000), cell wall by Robertson and Van Soest (1981) and zinc, copper by using the double beam atomic absorption spectrometer (SL-194, Elico Limited, Hyderabad, India. The samples were aspirated 10 times to record the mineral content, from the calibrated graph the concentration of test sample was determined vis-à-vis the standard. The collected data were analyzed by using suitable software.

## Results and Discussion

The chemical composition of calf starter and heifer feed containing organic (treatment) and inorganic (control) copper and zinc indicated that although the ingredient composition was same in the both groups for calf starters and heifer feed, there was slight difference in the chemical composition probably due to mixing differences (Table 2 and 3).

## Body weight and measurements

Results of effects of organic and inorganic copper and zinc supplementation in the ration of buffalo calves on the various body measurements i.e. body weight, length, height, heart girth, paunch girth, pin bone length and hook bone length that relate to physical growth have been given in Table 4. Results indicated that the physical parameters were similar in $TMR_{IM}$ and $TMR_{OM}$ fed calves. The average daily gain was 462.5 and 537.5 gm in $TMR_{IM}$ and $TMR_{OM}$ respectively, though the difference was non-significant. Huang *et al.,* (2010) suggested ADG (average daily gain), ADFI (average daily feed intake) and G/F (gain: feed) ratios showed no significant differences in organic and inorganic fed group. Kessler *et al.,* (2003) found that the Zn proteinate and Zn polysaccharide, compared with Zn oxide and a control treatment without Zn supplementation had no significant effect on the growth rate or feed conversion ratio. Growth performance was linearly improved as the dietary level of Cu increased from 15 to 200 mg/kg, with similar responses for both Cu sources i.e., copper sulfate (CuSO4) and a copper lysine complex (CuLys) by Apgar *et al.,* (1995). The recommended requirement of zinc in cattle is 35mg /day (NRC, 2001).

Diet containing about 32.5 mg Zn/kg DM was adequate to support normal growth and digestibility (Mandal *et al.,* 2007). Results of growth study also supported by Pal *et al.,* (2009) they observed average daily feed intake and body weight gain of ewes did not differ due to dietary supplementation of Cu- and Zn-methionine as compared to sulphate form.

Controversial reports are available on growth related effects. Our results support the results of Pal *et al.,* (2009) who observed no significant body weight gain in ewes fed inorganic and organic sources of copper and zinc. Similarly, Satyanarayana *et al.,* (2017) concluded that replacement of inorganic Zn with organic source had no significant effect on heifers body weight gain, growth performance.

**Table.1** Ingredient composition of the formulated mineral mixture for growth study

| Type of mineral source | $MM_{IM}$ | $MM_{OM}$ |
|---|---|---|
| **DCP** | 59.77 | 59.77 |
| **LSP** | 22.91 | 22.91 |
| **MgO** | 7.83 | 7.83 |
| **$MgSO_4$** | 4.98 | 4.98 |
| **$CuSo_4$** | 0.427 | ------ |
| **Lysine-Cu** | ----- | 0.427 |
| **$MnSo_4$** | 0.427 | 0.427 |
| **KIodate** | 0.050 | 0.050 |
| **$CoSo_4$** | 0.050 | 0.050 |
| **$FeSo_4$** | 1.50 | 1.50 |
| **$ZnSo_4$** | 2.06 | ----- |
| **Lysine-Zn** | ----- | 2.06 |

**Table.2** Ingredient composition of the formulated calf starter

| Ingredients | $CM_{IM}$ | $CM_{OM}$ |
|---|---|---|
| Maize | 36 | 36 |
| Bajra | 5 | 5 |
| Sodium bicarbonate | 0.5 | 0.5 |
| Corn germ meal | 3 | 3 |
| Maize oil cake | 5 | 5 |
| DGN cake | 5 | 5 |
| Mustard cake | 5 | 5 |
| Soya meal | 17 | 17 |
| Full fat roated soy | 5 | 5 |
| Rice bran | 9 | 9 |
| Wheat bran | 5.5 | 5.5 |
| Mineral mixture ($MM_{IM}$) | 2.00 | ---- |
| Mineral mixture ($MM_{OM}$) | ---- | 2.00 |
| Salt | 1 | 1 |
| $AD_3$ | 0.05 | 0.05 |
| Yeast | 0.2 | 0.2 |
| Biomass | 0.05 | 0.05 |
| Rumensin | 0.001 | 0.001 |
| Toxin binder | 0.1 | 0.1 |
| Biotin | 0.2 | 0.2 |
| Vitamin E | 0.5 | 0.5 |

**Table.3** Chemical composition of calf starter (% DM) containing mineral mixture prepared from organic and inorganic copper and zinc

| Parameters, %DM basis | Calf starter | Green fodder |
|---|---|---|
| CP | 22.3 | 9.6 |
| Ash | 10.1 | 9.57 |
| OM | 89.9 | 90.43 |
| EE | 4.5 | 2.89 |
| NDF | 28.5 | 65.2 |
| ADF | 9.4 | 36 |
| Hemicellulose | 19.1 | 29.2 |
| cellulose | 6.3 | 32.45 |

**Table.4** Body weight and measurements of female buffalo calves

| Parameter | $TMR_{IM}$ | $TMR_{OM}$ | p-value |
|---|---|---|---|
| Birth weight, kg | 31.4±2.70 | 27.8±1.98 | 0.33 |
| B wt at 5 months, kg | 98.0±6.22 | 105.2±10.64 | 0.42 |
| ADG, g/d | 462.5±0.11 | 537.5±0.14 | 0.36 |
| Body measurements, cm | | | |
| Length | 82.8±3.50 | 80.4±5.05 | 0.38 |
| Height | 87.4±2.36 | 87.8±4.07 | 0.5 |
| Heart girth | 104±3.36 | 104±5.40 | 0.36 |
| Paunch girth | 109.8±3.47 | 107.2±5.70 | 0.47 |
| Hip bones | 21.0±1.14 | 19.2±1.07 | 0.22 |
| Pin bones | 12.0±0.55 | 10.4±0.98 | 0.21 |

**Table.5** Nutrient digestibility and N- Balance of female buffalo calves

| Parameter | $TMR_{IM}$ | $TMR_{OM}$ | p-value |
|---|---|---|---|
| DMI, Kg | 2.41±0.13 | 2.44±0.09 | 0.40 |
| DMI, % b wt | 2.41±0.22 | 2.39±0.07 | 0.46 |
| Digestibility Coefficients, % | | | |
| DM | $59.62^{a}$±1.62 | $64.19^{b}$±1.11 | 0.01 |
| OM | 71.36±1.06 | 73.06±0.84 | 0.10 |
| CP | $68.25^{a}$±1.19 | $71.03^{b}$±1.03 | 0.04 |
| EE | $70.38^{a}$±2.39 | $77.71^{b}$±0.81 | 0.001 |
| NDF | $44.53^{a}$±2.49 | $54.57^{b}$±2.82 | 0.005 |
| ADF | 42.62±1.80 | 45.51±1.62 | 0.15 |
| N-balance, g/d | | | |
| N intake | 50.51±2.79 | 51.70±1.79 | 0.46 |
| Fecal N | 15.84±1.01 | 14.69±0.78 | 0.19 |
| Urinary N | 20.80±1.38 | 23.13±1.50 | 0.11 |
| N retained | 13.80±1.66 | 13.88±1.70 | 0.48 |
| % of absorbed N retained | 26.90±2.73 | 26.47±2.84 | 0.45 |

**Table.6** Blood biochemical profile at 5 months of age

| Parameter | $TMR_{IM}$ | $TMR_{OM}$ | p-value |
|---|---|---|---|
| Glucose, mg/dl | $56.66^{a}$±10.75 | $78.68^{b}$±8.44 | 0.02 |
| Triglycerides, mg/dl | 18.21±2.00 | 20.14±1.60 | 0.26 |
| BUN, mg/dl | 44.48±0.78 | 37.77±2.34 | 0.06 |
| Total protein, mg/dl | $6.15^{a}$±0.09 | $6.38^{b}$±0.13 | 0.05 |
| GGT | 13.11±1.47 | 15.87±2.35 | 0.47 |

**Nutrient utilization**

Results of the digestion trial (Table 5) indicated similar total TMR intake but significantly ($P<0.01$) higher digestibility of DM ($P<0.05$), CP ($P<0.01$), EE ($P<0.01$), NDF ($P<0.05$) in $TMR_{OM}$ in comparison to $TMR_{IM}$ fed group. Better digestibility of CP

and energy sources led to higher (P<0.01) percent DCP and TDN intake. Reported literature suggests that supplemental Cu, Mn and Zn facilitate the growth of cellulolytic rumen microbes like *Ruminococcus* sp. and *Fibrobacter* sp. which results in better ferment ability and utilization of organic matter. Our results have been supported by Balabanova *et al.,* (2011) who reported that mineral supplementation improved (P<0.05) crude protein, fat, fiber and nitrogen free extract digestibility in cows when compared to control. However, digestibility of cellulose and acid detergent fibre was significantly (P<0.05) higher in organic group as compared to control group by Garg *et al.,* (2008). Ashmead and Ashmead (2004) also observed significantly higher digestibility of feed nutrients in Holstein first calf heifers fed organic Cu and Zn as compared with inorganic micro-minerals. The difference in N-balance was non-significant as higher digestibility of CP in $TMR_{OM}$ was coupled with higher urinary N excretion.

## Blood profile

The blood biochemical profile is given in Table 6. The glucose, and total protein were significantly (p<0.05) higher in $TMR_{OM}$ as compared to $TMR_{IM}$. The other blood parameters were similar in both the groups. The buffalo calves fed zinc-lysine and Cu-lysine and inorganic Zn and Cu based TMRs exhibited no difference DMI and body measurements but supplementing organic minerals improved nutrient utilization and daily gain. It may be concluded that use of organic copper and zinc may be beneficial for improving growth, nutrient utilization and health of female buffalo heifers.

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