

EFFECT OF ZINC SUPPLEMENTATION FROM INORGANIC AND ORGANIC SOURCES ON NUTRIENT DIGESTIBILITY, SOME BLOOD METABOLITES AND GROWTH PERFORMANCE OF GROWING BUFFALO CALVES

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SUMMARY

This study was conducted to determine the effects of zinc supplementation either from inorganic or organic sources on digestibility, blood metabolites and animal performance. Twelve buffalo calves of 11-13 months of age weighing 257.66 ± 26.41 kg were divided into three similar groups of 4 calves each, where G1 was served as control ration, and was fed the basal diet consisting of roughage and concentrate mixture. While the two tested groups were fed the same basal diet, but supplemented with 30 mg Zn/head/day of Zn sulphate (G2). And supplemented with 30 mg Zn/head/day as Zinc methionine (G3). The basal diet contains 28.3 mg/kg Zn, and, additionally, the doses of Zn in the tested groups were orally supplemented. All animals of these groups were fed 80% of their requirements as concentrate mixture and the rest of requirements were covered from wheat straw and alfalfa hay in equal quantities. The daily requirements of energy and crude protein for growing calves were covered according (NRC, 2001). Results indicated that supplemented Zn methionine or Zn sulphate to calves diet increased significantly ($p < 0.05$) all nutrient digestibilities and feeding value in terms of TDN and DCP as compared with control group. Also, Supplemented Zn methionine for calves' diet increased significantly ($p < 0.05$) the concentration of serum Zn, plasma T3 and decreased significantly ($p < 0.05$) cholesterol concentration as compared with Zn sulphate and control groups. While, serum total protein, Albumin, globulin, and AST were not affected significantly by zinc supplementation from inorganic or organic sources in buffalos calves in comparison with control ration. The body weight and daily gain were significantly higher ($P < 0.05$) for calves fed supplemented Zn-methionine or zinc sulphate ration, than those fed control one. The body weight gain in Zn-methionine group was increased by about 35.29% and 16.59 % than those fed control or zinc sulphate ration, respectively. There was no significant difference in total feed intake among different groups. Supplementation of Zn-meth significantly ($P < 0.05$) improved the feed conversion efficiency and the feed cost/kg weight gain as compared with Zn sulphate and control groups.

From the results of this study it could be concluded that supplemented zinc from inorganic or organic sources in buffalo's calves diets improved digestibility and performances of growing buffalo and calves could be recommended that supplement Zn-methionine to growing buffaloes calves rations under Upper Egypt conditions because of its higher bioavailability than Zn sulphate.

Keywords: *growing buffalo calves, Zn-methionine, Zn sulphate, performance, blood metabolites, nutrient digestibility, feeding value*

INTRODUCTION

Zinc is essential for both human beings and animals and plays significant role in different enzymatic systems needed in nucleic acid metabolism, protein synthesis and carbohydrate metabolism (Chester, 1997). Zinc also may play important roles in thyroid metabolism. Thus, its low (Gupta *et al.*, 1997; Ruz *et al.*, 1999) or excessive (Dean *et al.*, 1991) levels may cause numerous abnormalities, of metabolic processes. Therefore, it has been emphasized that excessive dietary zinc intake resulted in disturbances in serum thyroid hormone levels in human (Miyamoto *et al.*, 1991) and animals (Dean *et al.*, 1991). Excess zinc has been found to decrease the levels of serum thyroxine (T_4) and triiodothyronine (T_3) in poultry (Dean *et al.*, 1991) and in humans (Nishiyama *et al.*, 1994).

Marginal deficiency of zinc in ruminants has been reported in many parts of the tropical countries including different geological regions or most growing plants in Egypt (El-Fouly *et al.*, 1984) and thus needs supplementation in the diets of livestock (McDowell, 1992). Also, Corah and Dargatz (1996) reported that 97.5% of forages analyzed were stated in range from deficient to marginal in Zn in this respect, some reports recorded that the minimum zinc level of the diet must be 20–33 mg Zn/kg diet in ruminants (National Research Council, 1985 and McDowell, 1992). The Beef Cattle National Research Council (NRC, 2000) recommends that beef cattle feedlot diets contain 30 mg Zn/kg DM, despite a survey of consulting feedlot nutritionist indicated that feedlot diets are formulated to contain, on average, 93 ppm Zn with a range of 40 – 213 ppm (Vasconcelos and Galyean, 2007). On the other hand, National Research Council, (1984) reported that Zn concentrations of 500mg/kg of diet will cause toxicity in beef cattle, however most livestock species tolerate concentrations as high as 1000 mg/kg in the diet (McDowell, 1992). Spears and Kegley (2002) have reported an improvement in the growth rate of calves on supplementation of 25 mg Zn/kg DM, over a basal diet that contend 33 mg Zn/kg DM.

Traditionally, the major sources of Zn amongst the mineral supplements for animal feeding have been its inorganic salts like Zn sulphate (ZnSO₄), Zn oxide (ZnO), Zn chloride (ZnCl₂), *etc.* However, recent studies showed that Zn supplementation through mineral proteinases or mineral amino acid chelates as organic sources which effectively had higher retention (Lardy *et al.*, 1992), more bioavailability (Spears, 1989) and tissue concentrations (Cao *et al.*, 2000) relative to inorganic sources. The beneficial effects of chelation on mineral metabolism is well established. It is the safest and most natural conveyance for getting needed metal elements in the living system of the animal. It is a relatively new concept to create mineral chelates in bio-compatible and bio-available forms that are transported to and utilized to the needed metabolic sites. Hempe and Cousins (1989) reported that Zn-methionine complex is transported intact from the intestinal lumen into mucosal cells, increasing tissue supply of Zn and thereby improving animal productivity. Also, Power *et al.* (1994) showed that the bioavailability of zinc proteinate to be 159% of the bioavailability of zinc sulfate in rats.

The objective of this research was to evaluate the effect of the supplementation of zinc sulphate and zinc Zn-methionine as sources of supplemental Zn in the diet on growth performance, nutrient digestibility, and blood metabolites of growing buffalo calves.

MATERIALS AND METHODS

Animals, rations and management

The experiment was carried out at the research farm of Faculty of Agriculture, Al-Azhar University, Assiut branch, Egypt. Twelve healthy buffalo calves of 13-14 months of age weighing 257.66 ± 26.41 kg were divided into three groups of (4 animals each) on the basis of their average live body weight. Group 1 was kept as a control and fed a basal diet consisting of roughage and concentrate feed mixture (CFM). Group 2 fed the basal diet supplemented with 30 mg Zn/head/day as Zn sulphate (Zn So₄), while Group 3 received the same basal diet that supplemented with 30 mg Zn/head/day as Zn-methionine (Zn-meth). The basal diet contains 28.3 mg/kg (DM basis). Zn, additionally, the doses of zn in the tested rations were orally supplemented. The source of zinc-methionine is Sulfozyme Agro Pvt. Ltd., India and the source of Zn sulphate is from the Egyptian market. Concentrate feed mixture contained 51% corn grains, 20% Corticated cotton seed meal, 25% wheat bran, 1% mineral mixture (without Zn), 2% limestone and common salt 1% .

The animal's requirements for CP and TDN were calculated according to NRC (2001). Where the concentrate to roughage ratio was 80:20, respectively based on DM and the roughage portion consisted of wheat straw and alfalfa hay and they were given in equal amount in each animal group all groups were fed 80% of their requirements as concentrate. The quantity of concentrate mixture was adjusted every month according to change in body weight (NRC, 2001). The animals were randomly allotted to experimental diets.

The ingredients and chemical composition of experimental diet are shown in Table (1). Rations were offered twice a day and the feed orts were weighed daily through the experimental period and actual feed intake was calculated. Feed conversion ratio was calculated and expressed in terms of kg dry matter (DM per one-kg body weight gain. Diets were mixed daily and fed twice a day. All the experimental animals were housed in a well-ventilated animal shed with cemented floor and provision of individual feeding and watering. The calves were weighed at the start of the feeding trial and then every month to determine changes in the body weight (BW), before marling feeding and drinking. Economic analysis of data was

done using the technique of Perrin *et al.* (1979). Clean drinking water with no detectable amounts of Zn was provided *ad libitum* twice (at 10 and 15 h). After 30 days of adaptation, calves were fed their respective treatment diets for a period of 120 days.

Table (1): Ingredients composition (g/kg DM) and chemical composition of concentrate mixture

Ingredients composition	%
Corn	51
Wheat bran	25
Corticated cotton seed meal	20
Limestone	2
Salt	1
Minerals Mixture	1
Total	100
Ash	6.79
Zn/mg/kg DM	28.3

Digestibility trials

Digestibility trials were conducted to determine the digestion coefficients for the three different experimental diets. Each digestibility trial was carried out using three buffalos. Calves and lasted for 12-day where the first 5-day was considered as a preliminary period followed by a 7-day collection period.

The rations were sampled daily during the trial and the samples were composited at the end of each trial, ground through 1 ml. screen, and stored for chemical analysis. Faeces were weighed just at the time of collection and 10% of the total amount were taken and dried at 60-70 °C for 24 h. The dried samples were mixed and ground for chemical analysis. The daily dried fecal samples from each animal were grounded through 1mm mill screen and saved for chemical analysis.

Chemical analysis and digestion coefficients measurements:

The chemical analysis of feeds and faeces were carried out according to the procedures of Association of Official Analytical Chemists (AOAC, 2000) using duplicate samples. The apparent digestion coefficients of nutrients were calculated by expressing the difference between the content of nutrient in both consumed feed and faeces as a percentage of its intake.

Blood sampling:

Blood samples were collected from the jugular vein monthly after the morning feeding. Blood samples were immediately centrifuged at 3000 rpm for 20 min. and serum was stored at -20 °C until analysis. Concentration of Serum total protein (TP) albumin (AL), ALT, AST and cholesterol were determined by spectrophotometer (Unico, USA) using commercial test kits (Spinreact, Spain). Serum globulin (GL) was obtained as the difference between the TP and AL concentrations. Concentration of zinc in serum was estimated in an air-acetylene flame using atomic absorption spectrophotometer (Model 5100, HGA- 600 Graphite Furnace; PerkinElmer, USA). Estimation of triiodothyronine (T3) and thyroxin (T4) in blood plasma samples was done by radioimmunoassay technique using an automatic gamma counter (Packard, USA, Model Cobra II) by the method suggested by Bhandarkar and Pillai (1982).

Statistical analysis

Statistical analysis was carried out using general linear model (G.L.M) of S.A.S (2001) program, version 8.2. Differences between groups in nutrient digestibility, blood metabolites and performance data were evaluated by one way ANOVA. The significance differences between treatments means were tested by Duncan Multiple Range Test (Steel and Torrie, 1980). The data were presented in mean \pm S.E.M and the level of significance was set at $P < 0.05$.

RESULTS AND DISCUSSION

Nutrients digestibility

The values of nutrient digestibility of the experimental rations are presented in (Table 2). Results of digestibility trials showed that supplemented Zn sulphate or Zn methionine to the tested rations (G2& G3) increased significantly ($p < 0.05$) all nutrients digestibility as compared with control groups.(G1), also, digestibility of most nutrients of zn-meth ration were significant higher than those of zn so4-ration. Similar results were confirmed by Salama Ahmed *et al.* (2003) who reported that increased digestibility of DM, OM and CP in dairy goats supplemented with 1 g/day Zn-methionine in their diet. Garg *et al.* (2008) found that supplementation of a diet containing originally 34mg Zn/kg DM, with 20mg of organic Zn/kg DM improved significantly ($P < 0.05$) ADF and cellulose digestibility in lambs, but DM, CP and NDF digestibilities were not affected, suggesting a positive role of organic Zn supplementation in fibre degradation. In contrast, Mandal *et al.* (2007) indicated that DM, CP, ADF and NDF digestibility were not affected by dietary Zn in bulls fed a basal diet (32.5mg Zn/kg DM) as it supplemented with 35mg Zn/kg DM. Also, Wenbin *et al.* (2008) found that digestibility of DM, CP, (NDF) and (ADF) did not differ ($P > 0.05$) among treatments groups that supplemented with 30 and 45mg Zn/kg DM for goats.

Table (2): Effect of source of zinc on nutrient apparent digestibility and feeding value %.

Items	Control (G1)	ZnSO4 (G2)	Zn-meth (G3)	P
DM	54.28 ^c ± 0.96	64.68 ^b ± 0.16	74.81 ^a ± 0.27	0.0001
OM	57.64 ^c ± 0.79	67.46 ^b ± 0.12	76.40 ^a ± 0.26	0.0001
CP	73.36 ^c ± 0.79	79.04 ^b ± 0.57	86.45 ^a ± 0.40	0.0001
CF	40.80 ^c ± 1.38	55.55 ^b ± 1.20	70.36 ^a ± 0.75	0.0001
EE	86.38 ^b ± 2.07	93.48 ^a ± 0.59	93.68 ^a ± 1.25	0.0018
NFE	56.91 ^c ± 1.16	67.39 ^b ± 0.36	75.24 ^a ± 0.37	0.0001
TDN, %	58.52 ^c ± 1.56	67.96 ^b ± 1.20	74.05 ^a ± 0.61	0.0001
DCP	8.38 ^c ± 0.12	9.33 ^b ± 0.07	9.66 ^a ± 0.09	0.0001

Means within row bearing different superscripts differ significantly ($p < 0.05$).

ZnSO4: Zn sulphate (added Zn = 30 mg/head/day).

Zn-meth: Zn-methionine (added Zn = 30 mg/head/day)

The feeding value in terms of total digestible nutrients (TDN), was significant higher for calves fed diets with Zn methionine or Zn sulphate than that fed the control diet. Also the TDN value for zn-meth ration was significantly higher than that of znso4- ration. The improvement in the feeding value of calves fed Zn methionine or Zn sulphate than that of control may be due to the higher values of nutrient digestibility (Table2).

Blood metabolites

The data in Table (3) revealed that there were no significant effects ($P > 0.05$) in concentrations of serum total protein, Albumin, and globulin due to the two Zn source supplements for calves, based on control ration. The average value of ALT in blood serum of calves fed diet supplemented with Zn-methionine was higher ($P < 0.05$) than those fed diet supplemented with Zn-sulphate (30.77 vs. 25 Unit/l). However, no significant differences were observed among groups for AST. These results are in contrast with those reported by Shinde *et al* (2013) who found that ALT activities significantly ($p < 0.05$) declined in Cu- and Zn-met group than Cu- and Zn sulphate indicating an effective role of chelated minerals in improving liver function. Daghash and Mousa (1999) observed higher ALT and AST activity in buffalo calves supplemented with 50 or 100 ppm Zn.

The average value of cholesterol for calves fed diets supplemented with Zn-methionine or Zn-sulphate were significantly lower than those fed control (196.96 and 209.61 vs. 230.47) respectively. From these results it could be noticed that there are inverse relationships between thyroxin level and cholesterol level. This agrees with the statement of Guyton *et al.* (1991) and Guyton *et al.* (2000) who mentioned that the increase in the basal metabolic rate (high thyroxin level) is accompanied by a drop of the plasma total cholesterol level. Miroslaw *et al* (2007) reported that enrichment of diet with Se, Zn and vitamin E (0.42,

68 and 60 mg /lamb/day, respectively) significantly decreased the cholesterol content of loin muscle and the level of total cholesterol of blood plasma with simultaneously lower HDL level

Table (3): Effect of source of zinc on blood metabolites

Item	Control (G1)	ZnSO4 (G2)	Zn-meth (G3)	P
Total protein (g/dl)	7.41± 0.18	7.31± 0.09	7.36± 0.23	0.854
Albumin (g/dl)	4.55 ±0.07	4.52± 0.02	4.51 ± 0.02	0.776
Globulin (g/ dl)	2.86± 0.21	2.79± 0.09	2.85 ± 0.22	0.164
A/G ratio	1.60 ± 0.19	1.63± 0.06	1.90 ± 0.43	0.289
ALT (U/l)	30.00 ^a ± 1.90	25.00 ^b ± 0.94	30.77 ^a ± 1.38	0.020
AST (U/l)	17.55 ± 2.25	17.11± 1.94	19.77 ± 2.11	0.635
Cholesterol mg/dl	230.47 ^a ± 8.49	209.61 ^b ± 7.01	196.96 ^b ± 4.51	0.007
Zinc, mg l	1.33 ^c ± 0.02	1.55 ^b ± 0.01	1.62 ^a ± 0.01	0.0001
T3, nmol/l	1.81 ^c ± 0.07	2.13 ^b ± 0.04	2.30 ^a ± 0.04	0.0001
T4 , nmol/l	87.89 ± 3.01	91.22 ± 3.49	93.22 ± 6.15	0.695

Means within row bearing different superscripts differ significantly ($p < 0.05$).

ZnSO4: Zn sulphate (added Zn = 30 mg/head/day).

Zn-meth: Zn-methionine (added Zn = 30 mg/head/day).

Results in the present work showed that level of serum Zn (Table3) was significantly increased ($P < 0.05$) in Zn-methionine group as compared with Zn-sulphate or control groups. Also, calves fed diet supplemented Zn-sulphate was significantly higher ($P < 0.05$) for serum Zn concentration than control group. These results are in agreement with those obtained by Abou-Zeina *et al* (2009) in buffalos, Garg *et al* (2008) in lambs, Hayat *et al* (2010) in goats and Huerta *et al.*(2002) in beef steers. These findings indicating highly bioavailability of Zn that released from Zn-Met supplementation and effective absorption via intestinal transport mechanisms. Also, Hempe and Cousins 1989 reported that Zn-Met complex is transported intact from the intestinal lumen into mucosal cells, which increasing tissue supply of Zn and thereby improving animal productivity. Moreover, Fadayifar *et al* (2012) suggests that adding 20 or 40 mg Zn/kg DM to a barley based diet containing 22.47 mg Zn/kg DM will increase plasma Zn concentration of lambs. Comparable results recorded by Huerta *et al.* (2002) who reported that heifers fed the diet with Zn-Meth had higher ($P < 0.05$) concentration of Zn in serum than heifers fed the control or Zn SO4 supplemented diets. Contrary to this, Mandal *et al.* (2008) found that serum Zn levels did not differ ($P > 0.05$) for steers fed zinc sulphate and zinc propionate. Similarly, Spears *et al.* (2004) did not find any effect of organic Zn supplementation on plasma Zn concentration in steers, fed.

Concerning thyroid hormones analysis, results of the present study revealed that Zn-methionine and Zn-sulphate had a positive effect on total T₃ which was significantly elevated due to those supplements , meanwhile, the mean concentration of total T4 kept unchanged significantly due to the tested rations (G2 &G3) based on control one (G1) (Table 3). These results are in agreement with other studies which denoting that Zn supplementation increased total T3 (Abou-Zeina *et al.*, 2009 and Hayat *et al* 2010). In addition to its participation in protein synthesis, Zn is essential for proper thyroid function. It is involved in T3 binding to its nuclear receptor (Liu *et al* 2001). Also, Zn participates in synthesis and action of thyrotropin-releasing hormone (TRH). Based on these results, it is clear that there are correlations between the level of serum zinc and plasma T3 and T4 levels (Nishi *et al.*, 1980; Aihara *et al.*, 1984). Similar results observed by EI-Sisy *et al.* (2008) who reported that the total T₃ was significantly increased in bucks fed diets supplemented with zinc yeast as compared with the control one. While the mean concentration of total T4 kept constant through the course of the study. Kececi and Keskin (2002) reported that lambs and goats in the Zn groups (40 mg/kg DM for lambs and 35 mg/ kg DM for goats) had significantly higher ($P < 0.05$) in plasma Zn values than the control one. Contrary to the above results Mandal *et al.* (2008) indicated that supplemental zinc either from inorganic or organic sources did not influence plasma T3 and T4 concentration in crossbred calves.

Calves performance

Results presented in (Table 4) showed that the body weight gain and daily gain were significantly higher for calves fed supplemented Zn-methionine or zinc sulphate ration than those fed control one. The body weight gain in Zn-methionine group was higher by about 35.29% and 16.59 % than those fed with control and zinc sulphate respectively. It was expected that Zn-methionine supplementation had

improved ADG due to increasing methionine absorption and stimulating activities of enzymes involved in nutrients digestibility, feeding value and feed efficiency (Tables 2, 4). Also, this study supports the concept that organic Zn may be metabolized differently from inorganic Zn and, thus, may alter some metabolic processes differently (Spears, 1996). These results are in agreement with those reported by Garg *et al.* (2008) and Puchala *et al.* (1999) who found that the average gain and feed efficiency were higher in lambs consuming a diet supplemented with 20 mg Zn/ kg DM as Zn-methionine than those fed that free from organic zinc control. Similarly, Ward *et al.* (2002) observed greater weight gains for animals that ingested zinc in the organic form. Spears and Kegley (2002) also reported higher weaning weights for calves supplemented with organic zinc when compared with control groups that received zinc oxides or sulfates. Also, Kegley and Silzeli (1999) reported that the weight gain was improved in calves supplemented with Zn to a basal diet containing 21 mg Zn per kg diet. Such results are in contrast to those of Wright and Spears (2004) who reported similar growth performance in calves supplemented with 20 mg Zn either as Zn sulphate or Zn proteinate to a basal diet having 28 mg Zn/kg DM. Similarly, Shinde *et al.* (2006) also did not observe any difference in the growth rate in the guinea pigs supplemented by Zn either through organic or inorganic sources.

Concerning DM intake Supplementation of 30 mg Zn/head/ day either as ZnSO₄ or Zn-meth had no effect on total DMI of calves as it was comparable with control group that free from these supplements. (Table 4). These results are in agreement with those reported by Khan (1978) who did not find any effect on DMI in growing calves, when level of Zn was increased from 26.02 to 85.67 mg/kg DM in their diet. Similarly, supplementation of Zn-methionine to a basal diet (containing more than 25 mg Zn/kg DM) had no effect on feed intake in ewes (Salama Ahmed *et al.*, 2003), growing lambs (Fadayifar *et al.*, 2012), beef steers (Malcolm-Callis *et al.*, 2000), bulls (Mandal *et al.*, 2007) and Cashmere goats (Wenbin *et al.*, 2008). These results indicate that normal dietary Zn concentrations either ZnSO₄ or Zn-meth forms do not influence DMI, but higher concentrations may have a negative influence on diet palatability (Malcolm-Callis *et al.*, 2000). Dietary levels of Zn in the current experiment were within normal ranges and would not affect diet palatability.

Table (4): Growth Performance of buffalo calves fed different sources of zinc.

Item	Control (G1)	ZnSO ₄ (G2)	Zn-meth (G3)	P
Initial weight (kg)	257.50 ± 27.53	257.00 ± 29.14	258.50 ± 22.55	0.999
Final weight (kg)	351.50 ± 26.60	365.50 ± 30.88	385.00 ± 23.63	0.686
BW gain (kg)	94.00 ^c ± 3.01	108.50 ^b ± 2.22	126.50 ^a ± 2.90	0.0001
Daily gain (kg)	0.783 ^c ± 0.18	0.904 ^b ± 0.16	1.054 ^a ± 0.05	0.0001
Feed Intake (FI, kg/day)				
DMI of concentrate	5.78 ± 0.086	5.83 ± 0.081	5.83 ± 0.081	0.951
DMI of wheat straw	2.20 ± 0.029	2.19 ± 0.028	2.19 ± 0.026	0.982
DMI of alfalfa	1.50 ± 0.000	1.50 ± 0.000	1.50 ± 0.000	1.000
Total DM intake	9.50 ± 0.100	9.52 ± 0.081	9.53 ± 0.081	0.965
Feed conversion ratio kg/kg gain)	12.19 ^a ± 0.13	10.53 ^b ± 0.09	9.07 ^c ± 0.085	0.0001
Feed cost/day E.P.*	21.46 ^c ± 0.23	22.09 ^b ± 0.19	22.87 ^a ± 0.21	0.0001
Feed cost/kg WG**	27.55 ^a ± 0.29	24.43 ^b ± 0.21	21.78 ^c ± 0.20	0.0001

Means within row bearing different superscripts differ significantly ($p < 0.05$).

ZnSO₄: = 30 mg/head/day).

Zn-meth: = 30 mg/head/day).

* E.P. =Egyptian pound ** WG=Weight gain

Regarding feed conversion ration data presented in Table (4) showed that supplementation of Zn-meth significantly ($P < 0.05$) improved feed conversion efficiency in comparison of control ration that have no supplement. Also, similar improvement due to Zn-So₄ supplement was observed respecting FCR, compared with control diet these results are in agreement with those reported by Puchala *et al.* (1999) who found that higher daily gain and feed conversion efficiency of Zn-Met supplemented ration for lambs as compared to the control one that have nothing supplement. Contrary to it, Shinde *et al.* (2006) did not find any difference in feed efficiency in supplemented Zn either through organic or inorganic sources to ration of guinea pigs. Similar observations were made in calves (Engle *et al.*, 1997; Mandal *et al.*, 2007) and steers (Spears *et al.*, 1991) who showed that Zn supplementation had no effect on feed efficiency with these animals.

In spite of the higher value for feed cost/day, for calves fed supplemented Zn-meth or ZnSO₄ as compared with control group (Table 4), the value of feed cost/kg weight gain was lower in Zn-meth or ZnSO₄ groups as compared with control. This may be due to the improvement in weight gain for these groups as compared with control.

CONCLUSION

On the basis of the present experiment, it may be concluded that supplementation of 30 mg Zn/head/day as Zn-methionine or Zn sulphate in addition of that naturally containing in the basal diet (containing 28.3 mg Zn/kg DM) of growing buffalo calves significantly improved all nutrients digestibility and some blood metabolites as increasing T₃ and decreasing concentration of total cholesterol. Also improvement in daily gain and feed conversion ratio were noticed in calves fed diet with Zn in Zn-methionine group compared to ZnSO₄ and control groups. So it could be recommended that to being supplement Zn-methionine to growing buffaloes calves rations under Egyptian condition because of its higher bioavailability than Zn sulphate.

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تأثير اضافة الزنك من مصادر غير عضوية وعضوية على هضم المكونات الغذائية وخصائص الدم واداء النمو لعجول الجاموس النامية

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تم اجراء هذه الدراسة على اثني عشر من العجول الجاموس النامية في عمر 11-13 شهر بمتوسط وزن حوالى 257 كجم وزعت على ثلاث مجاميع متماثلة بطريقة عشوائية اربعة بكل مجموعة لدراسة تأثير مصدر الزنك على القيمة الهضمية وخصائص الدم واداء العجول النامية. المجموعة الاولى (الكنترول) غذيت العجول فيها على العليقة المقارنة المكونة من مخلوط المركز العلف الخشن المكون من تبن القمح ودريس البرسيم الحجازى. المجموعة الثانية وفيها تم تغذية الحيوانات على العليقة المقارنة بالاضافة الى 30مجم/راس/ يوم كبريتات الزنك تم اعطائها عن طريق الفم. المجموعة الثالثة غذيت العجول على العليقة المقارنة بالاضافة الى 30مجم/راس/ يوم من الزنك مثنونين تم اعطائها عن طريق الفم. و تم تغطية 80% من الاحتياجات الغذائية للحيوانات من المواد المركزة بينما أعطى تبن القمح ودريس البرسيم بكميات متساوية لتكملة باقى الاحتياجات الغذائية من الطاقة و البروتين الخام علما بان كمية المواد المركزة يتم تغييرها شهريا تبعا للزيادة الشهرية وذلك طبقا لـ (NRC, 2001). أظهرت النتائج أن اضافة الزنك فى صورة الغير العضوية او العضوية الى العجول النامية رفع بصورة معنوية القيمة الهضمية لجميع العناصر الغذائية للعلائق المختبرة مقارنة بالكنترول كما زادت القيمة الغذائية للعليقة سواء فى صورة مركبات مهضومة كلية او بروتين كلى مهضوم. اضافة الزنك فى صورة الغير العضوية (الزنك مثنونين) اداى الى زيادة معنوية للزنك فى السيرم وهرمون T3 كما حدث نقص معنوى فى محتوى الكوليسترول عند المقارنة بمجموعة كبريتات الزنك او مجموعة المقارنة. لا يوجد تأثير لمصدر الزنك سواء غير عضوى او عضوى على كل من البروتين الكلى والاليومين والجلوبيولين ومعدل الاليومين الى الجلوبيولين و AST فى سيرم الدم. معدل الزيادة فى وزن الجسم ومعدل النمو اليومي اعلى معنويا فى العجول المغذاة على علائق مضاف لها زنك مثنونين او كبريتات الزنك مقارنة بالمغذاة على العليقة المقارنة. كان معدل الزيادة فى وزن الجسم للعجول المغذاة على الزنك مثنونين اعلى بحوالى 35.29 و 16.59 مقارنة بالمغذاه على كبريتات الزنك و العليقة الكنترول على التوالى. لا يوجد اختلافات معنوية فى الغذاء الماكول الكلى فى اليوم بين المجاميع الثلاثة. اضافة الزنك مثنونين اداى الى تحسن معنوى فى كل من الكفاءة الغذائية الكفاءة الاقتصادية عند المقارنة بمجموعة كبريتات الزنك او مجموعة الكنترول.

وقد خلصت الدراسة الى ان اضافة الزنك فى صورة الغير عضوية (كبريتات الزنك) او العضوية (الزنك مثنونين) اداى الى تحسين القيمة الهضمية واداء النمو فى عجول الجاموس النامية وكان افضل فى تكلفة كيلو النمو الا ان اداء الذنك العضوى كان الافضل و الفروق كانت مؤكدة احصائيا خاصة مع معدلات نمو العجول. ولذلك فان الدراسة توصى باضافة الزنك مثنونين الى علائق عجول الجاموس النامية للعمل على زيادة اداؤها الانتاجى تحت ظروف الانتاج السائدة فى مصر لانه اكثر اتاحة للحيوان من كبريتات الزنك وافضل من الناحية الاقتصادية.