THE EFFECT OF ZINC SUPPLEMENTATION ON PERFORMANCE OF GROWING LAMBS

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SUMMARY

This study was investigated to determine the effect of zinc source either from organic or inorganic on lambs performance, blood metabolites and carcass characteristics. Fifteen local lambs (about six months old and an average body weight of 26.5± 3.1 kg) were divided into three similar groups (5 lambs each). The control group (G1) was fed the basal diet consisting of wheat straw and concentrates mixture. While, the other two tested groups were fed the same basal diet, supplemented with 20 mg Zn/head/day as Zinc Sulphate (G2) and 20 mg Zn/head/day as Zinc methionine (G3). All animals of these groups were fed 60% of their requirements as concentrate mixture and the rest of other requirements were covered from wheat straw, which was given *ad libitum*. The experiment was extended for 6 month. The results indicated that the average daily gain (ADG) was higher ($P < 0.05$) in zinc sulphate and zinc methionine groups than in control group (130 and 132 gm/day vs. 99 gm/day, respectively). There were no significant differences among groups in total feed intake. Feed conversion ratio as dry matter intake/ g gain was improved in zinc methionine and zinc sulphate groups when compared with control one. However, the differences among groups were not significant. Supplementation of Zn-meth increased ($P<0.05$) the level of zinc in serum as compared with control and zinc sulphate groups. Also, serum cholesterol was higher ($p < 0.05$) in Zn treated groups than in control one. While, serum concentration of total protein, Albumin, globulin, glucose, triglycerides and total antioxidant capacity (TAC), were not affected by zinc supplementation. Zn supplementation in a form of organic or inorganic had no effect on dressing percentage and carcass cuts in lambs. In conclusion zinc supplementation in form of inorganic or organic may improve lambs performance.

Keywords: *growing lambs, Zn-methionine, Zn sulphate, performance, blood metabolites, carcass cuts.*

INTRODUCTION

Zinc is one of the important microelements which have effect on growth, reproduction and immune system by influencing enzyme activity of animals and gene expression (Chesters, 1997). Zinc is needed for the functions of over 100 enzymes and essential for DNA, RNA and absorbed amino acids, which involved protein synthesis and cell division in growing lambs and calves (McDowell, 1995). Also, zinc improves hoof quality (Kessler et al. 2003). The deficiency of Zn in ruminant diets includes reduce of feed intake, growth rate and feed efficiency (McDowell et al., 1993). Previous research has shown that a severe Zn deficiency can result in impaired growth and altered immune function in lambs (Droke and Spears 1993), and calves (Brummerstedt et al. 1971) and reduced wool growth of sheep (White *et al*., 1994). Traditionally, the major sources of Zn amongst the mineral supplements for animal feeding were inorganic salts like Zn sulphate ($ZnSO_4$), Zn oxide (ZnO), Zn chloride ($ZnCl_2$), etc. However, recent studies showed that Zn supplementation through mineral proteinases or mineral amino acid chelates as organic sources had higher retention (Lardy *et al*., 1992), more bioavailability (Spears, 1989) and higher tissue concentrations (Cao *et al*., 2000) compared to inorganic sources. 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.

Supplementation of Zn methionine to a diet containing more than 25 mg Zn/kg DM did not affect feed intake in ewes (Salama et al., 2003), goats (Puchala et al., 1999), growing lambs (Droke et al., 1998) and beef steers (Malcolm-Calliset al., 2000). Brethour, (1984) reported that supplement organic Zn improve growth performance and carcass characteristics of feedlot cattle. Spears (1989) concluded that the performance of heifers did not differ ($P >.10$) between that fed ZnO and those receiving Zn-Meth, however more improvement was noticed for the Zn-Meth treatment. Spears (1989) and Hill et al. (1987) found no differences in Zn bioavailability between organic and inorganic sources when they measure plasma Zn or plasma alkaline phosphatase as indices of Zn bioavailability. The aim of study is to examine the effect of zinc from organic and inorganic source on performance and carcass characteristic in growing lambs.

MATERIALS AND METHODS

Animals, rations and management:

The experiment was carried out at the experimental farm of Animal Production Department, Faculty of Agriculture, Assuit University, Egypt. Fifteen healthy local males (six month's old and 26.5± 3.1 kg weigh) were divided into three groups (five males each), according to their average live body weight. The average initial weights were similar in all groups. Lambs were kept in individual pens. Group one was served as control diets (G1) and was fed the basal diet consisting of wheat straw and concentrates mixture. While the other treated groups were fed the same basal diet, but supplemented with either 20 mg Zn/head/day of Zn sulphate (Zn-So4, G2) or 20 mg Zn/head/day as Zinc methionine (Zn-Met, G3). The doses of Zn were added to the diets as dietary supplement. The source of zinc-methionine is Sulfozyme Agro Pvt. Ltd., India.

The animal's requirements for CP and TDN were calculated according to NRC (1985). The animals were randomly allotted to experimental diets. All animals of these groups were fed 60% of their requirements as concentrate mixture and the rest of other requirements were covered from wheat straw, which was given *ad libitum* , the quantity of concentrated mixture were adjusted every two weeks according to changes in body weight (NRC,1985). Fresh water were available free of choice. Rations were offered once daily at 8.00 a.m. 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 gm dry matter (DM), total digestible nutrients (TDN) and starch value (SV) per gm body weight gain. Animals were fed individually in locally manufactured mangers. The experimental period lasted for 195 days and consisted of two periods, *i.e.* 15 adjustment period followed by 6 months experimental period. Animals were weighed in two days every other week before morning feeding. Body weight was averaged to the nearest 0.1 kg. The ingredients of concentrate mixture were corn (47%), wheat bran (20%), soybean meal (30%), limestone (2%) and salt (1%). The proximate analysis of concentrated mixture and wheat straw were clear in table (1).

Blood Sampling:

Blood samples were monthly taken from all animals at interval for determination serum total protein, albumin, globulin, cholesterol, triglyceride, zinc and total antioxidant capacity. Globulin was obtained by differences between serum total protein and albumin.

Slaughtering:

At the end of the experiment three animals of each group were slaughtered. Fasting body weight was record before slaughter. Immediately after slaughtering weight of head, pelt, liver, lungs, heart, spleen, kidneys, kidney fat, caul fat, sex organs and heart fat were recorded. Dressing percentage to fasting body weight was calculated. The carcass was splatted according to Brown and Williams (1979). Weights of tail, leg, loin, rack breast, 1-6 ribs, and 7-12 ribs were recorded too**.** The longissimus muscle piece was taken for proximate analysis to determine moisture, fat, crude protein and ash according to AOAC (2000).

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 performance, blood metabolites and carcass characteristics were evaluated by one way ANOVA. The significance differences between treatment means were tested by Duncan Multiple Range Test (Steel and Torrie, 1980). The data were presented in mean ± S.E.M. Level of significance was set at $P<0.05$. Statistical model as follow:

$$Y_{ij}= \mu + T_i + E_{ij}$$

Where: Y_{ij}= the observation ij, μ =the overall mean, T_i = the effect due to treatment i., E_{ij} = the experimental error.

RESULTS AND DISCUSSION

Body weight and average daily gain:

The average body weight gain (BWG) was not affected by Zn supplementation (Table 2). However, the average daily gain (ADG) of Zn-So4 and Zn-Met groups were higher ($P > 0.05$) than control one. Inclusion of Zinc sulphat and Zinc-Methionine as a dietary supplement to diets improved average daily gain of lambs by about 25 and 24% as compared with control group, respectively. Similar results were found by Garg *et al*. (2008) and Puchala *et al*. (1999). In addition, Spears and Kegley (2002) found no differences in performance of steers fed supplement with zinc oxide and zinc proteinate, but the ADG tended to be higher in steers fed zinc proteinate.

Feed intake:

The total DM intake was not affected by the source of zinc. However, the group fed Zn-Meth improved ($P<0.05$) total intake in terms of TDN, SV and DCP intake as compared with control group. Our results were agreement with previous results reported on lambs (Nagalakshmi and Himabindu, 2013), lactating cows (Wang et al., 2013), feedlot steers (Caldera, 2012) and buffalo calves (Hassan et al., 2016). The increase of TDN, SV and DCP intake with supplement of inorganic and organic Zn to the diet of lambs may be attributed to improve in nutrient digestibility (Garg et al., 2008). However, Malcolm-Callis et al. (2000) found negative effect with Zn supplementation on DMI. Such effect may be due to higher intake of Zn decreased diet palatability. Dietary levels of Zn in the current experiment were within normal ranges and would not affect diet palatability (NRC, 1985).

Feed conversion ratio:

Regarding feed conversion ratio expressed as g DMI, TDN and SV /g gain for lambs fed Zn-Meth, Zn-So4 and control diet were shown in table (2). Although no significant differences were observed among groups, however, numerical differences were found among groups. Lambs fed Zn-Meth and Zn-So4 recorded lower DM, TDN and SV unit/unit of gain than lambs fed control diet. The lowest DCP required for each gain unit was observed in lambs fed control group. The improvement of fed conversion in groups fed Zn-Meth and Zn-So4 may be attributed to higher daily gain of these groups or due to improve feeding value for such diets in terms of TDN and SV. The results in our study agreement with those of Nagalakshmi and Himabindu (2013), they found that ether dose or source of Zn had no significant effect on weight gains, nutrient intake and feed efficiency of lambs. Fadayifar et al. (2012) showed that supplementation of 20 mg Zn/kg DM to the basal diet improved performance (average daily gain and feed efficiency) of lambs. Similar observations were found in calves (Wright and Spears, 2004 and Mandal et al., 2007) and steers (Spears et al., 1991).

Concentrations of blood metabolites:

The data in Table (3) revealed that there were no significant differences ($P>0.05$) in serum total protein, albumin, globulin, glucose, triglycerides and total antioxidant capacity (TAC) of lambs due to Zn-supplemented diet. However, the average value of serum cholesterol concentration of lambs fed diets supplemented with Zn-SO4 or Zn-Meth were higher ($P>0.05$) than that of lambs fed control diet. The higher value of cholesterol may be attributed to the increase of thyroid gland activity as a result of Zn supplementation. Liu *et al*. (2001) reported that Zn is essential for proper thyroid function and participates in synthesis and action of thyrotropin-releasing hormone (TRH). Similar results were observed by Hassan *et al.* (2016) who reported that Zn-methionine and Zn-sulphate had a positive effect on total T_3 which was significantly elevated due to Zn supplements to buffaloes claves ration. Similar result observed in lambs by Berrie et al. (1995), they found that addition of Zn- Meth to feed of lambs increased serum growth hormone, prolactin, and triiodothyronine as compared with inorganic Zn or control groups. Nazifi *et al.* (2002) found significant positive correlations between serum thyroxin and cholesterol and triglyceride levels in clinically healthy male camels. however, others studies showed no significant correlation between serum thyroid hormones and cholesterol levels in camels, male goats and fat tailed sheep (Nazifi et al., 2007 and Mansourian, 2010).

Results of the present work showed that level of serum Zn was increased ($P<0.05$) in Zn-Meth group as compared with Zn-So4 and control groups. Our result suggests that adding 20 mg/head/day from organic source to growing lambs' diet containing 22 mg Zn/kg DM will increase serum Zn concentration. Similar to our findings, previous evidence demonstrated that supplementation of Zn could increase the plasma Zn concentration in male goats (Salama *et al.,* 2003) and finishing lambs (Fadayifar *et al.,* 2012). Spears *et al.* (1989) attributed the higher value of plasma Zn with Zn-Meth supplementation due to slower release of Zn from the Zn-Meth and this increase Zn absorption, besides facilitating Zn transport across the intestinal mucosa. Garg *et al.* (2008), also suggested that the bioavailability of was higher as compared to ZnSO4. Similarly, Hassan *et al*, (2016) found that the level of serum Zn of buffaloes calves was increased ($P<0.05$) in Zn-meth group as compared with Zn-SO4 or control groups. Also, calves fed diet supplemented with Zn-sulphate was higher ($P<0.05$) for serum Zn concentration than control group.

The effect of zinc source on Carcass characteristics:

Results presented in table (4) showed that there are no significant ($P<0.05$) differences between control group and groups fed different sources of zinc in hot carcass, dressing percentage, internal organs and carcass components except the weight of head, the pelt weight and hot carcass, which these are significantly ($P<0.05$) higher in group fed Zn-Meth than Zn-SO4 and control groups. Also, the right and left sides weights tended to be higher in lambs fed different sources of zinc as compared with control group. Results indicated that the hot carcass was affected by the slaughter weight. These results are conformed by Cameron and Drury (1985) who found a highly significant ($P<0.01$) effect of slaughter weight on hot carcass in lambs. Haryanto *et al.* (1994) reported that slaughter weight, carcass yield, carcass percentage and carcass linear measurement did not differ between control and zinc methionine treatment. Similarly, Berrie et al. (1995) found no differences on cold or hot carcass weight, dressing percentage, kidney, pelvic, and heart fat for lambs groups received either zinc methionine or Zn-So4. Nagalakshmi and Himabindu (2013) found that the dose and source of Zn had no effect on the pre slaughter weight, hot carcass weight, dressing percentage and edible and non-edible proportion of carcass. Greene et al. (1988) reported that zinc oxide did not affect carcass traits, but Zn methionine increased fat thickness, percentage of kidney, pelvic and heart fat, and quality grade compared to control and ZnO-supplemented steers.

Table (5) showed that the rack breast weights of lambs fed Zn-Meth is higher by about 32 and 23 % than control and Zn-So4, respectively. Also, the tail weight was increased by about 40% in Zn-Meth and 48% in Zn-So4 as compared with control group, respectively. Such improvement of carcass components may be due to the increase of both daily gain and body weight of lambs fed zinc. Gravet and Rosenhahn (1965) found a positive correlation between daily gain and the percentages of muscular tissues and fat. Nagalakshmi and Himabindu (2013) found that the meat yield was higher and fat yield was lower in $ZnSO_4$ fed lambs compared to Zn proteinate.

The chemical analysis of longissimus muscle in table (6) show that the supplement different sours of zinc not significantly effected on longissimus muscle composition. However, a numerical difference is found in fat composition of longissimus muscle. Lambs received Zn-Meth as dietary supplement decrease fat content in longissimus muscle by about 43 and 65 % when compared with control and Zn-So4, respectively. This finding with lambs differs from previous data that suggested Zn-Met supplementation increased marbling in beef cattle (Greene et al., 1988 and Spears and Kegley, 2002), but agrees with the results of other studies (Martin et al., 1987 and Stobart et al., 1987). Greene et al. (1988) attributed the improving in marbling score with supplement Zn-Meth due to increase supply of methionine to the small intestine for absorption. Field et al. (1985) attributed the rule of Zn for decrease carcass fat due to alter lipid metabolism or it could be indirect through hormones such as luteinizing hormone, follicle stimulating hormone and testosterone which are influenced by level of Zn in the diet (Lei et al. 1976). Also, the effect of Zn oxide could also be indirect through its effect on rumen microbial activity and subsequent volatile fatty acid production (Ott et al. I966).

CONCLUSION

From the present study it could be concluded that supplementation of 20 mg Zn /head/day either Zn-Meth or Zn-SO4 to basal ration of lambs contain about 40 mg/Zn/kg DM improved daily and feed conversion ratio of growing lambs. The addition of Zn-Meth to diets of lambs increased serum zinc. Also, serum cholesterol was increase in Zn supplement groups. The dressing percentage and carcass characteristics not affected with supplement zinc.

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تأثير اضافه الزنك على أداء الحملان النامية

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أجريت هذة الدراسه لبحث تأثير أضافة الزنك إما من مصادر عضوية أو غير عضوية وطريقة الأعطاء على أداء الحيوانات ومكونات الدم وصفات الذبيحة. خمسه عشر حمل محلى نامي عند عمر ٦ أشهر ووزن ٢٦.٥±٣.١ تم تقسيمهم إلى أربع مجموعات متماثلة كل مجموعة بها ٥ حملان ، المجموعة الأولى (م١) قدم لها العليقة الأساسية. فى حين المجموعات المختبرة الأخرى هى: المجموعة الثانية (م٢) قدم لها العليقة الأساسية مضاف إليها ٢٠ ملجم زنك/ رأس/ يوم فى صورة كبريتات الزنك والمجموعة الثالثة (م٣) قدم لها العليقة الأساسية مضاف إليها ٢٠ ملجم زنك / رأس/ يوم فى صورة زنك ميثيونين. جميع الحيوانات تم تغطيه ٦٠% من احتياجاتها من المخلوط المركز فى حين تم تغطيه باقى الاحتياجات من التبن فغذى حتى الشبع. التجربه استمرت لمدة ٦ شهور.أظهرت النتائج أرتفاع معدل الزيادة اليومية بصورة معنوية (عند مستوى 5 %) فى مجموعات كبريتات الزنك والزنك ميثيونين إذا ما قورنت بمجموعه الكنترول (١٣٠ و ١٣٢ جم مقارنه ب ٩٩جم) على التوالى . لا يوجد اختلافات معنويه فى الغذاء الماكول الكلى بين المجاميع. معدل الكفاءة الغذائية على اساس مادة جافة تحسن فى مجاميع الزنك ميثيونين وكبريتات الزنك مقارنه بمجموعه الكنترول.. أضافة الزنك ميثيونين رفعت من مستوي الزنك فى سيرم الدم بصورة معنوية (عند مستوى ٥%) مقارنة بمجموعة الزنك سلفات ومجموعة الكنترول. كذلك أرتفع مستوي الكوليستيرول فى سيرم الدم بالمجموعات المعاملة بالزنك إذا ما قورنت بالكنترول . بينما كل من بروتينات السيرم الكلية ، الألبيومين ، الجلوبيولين ،الجلوكوز، الجليسريدات الثلاثية و مضادات الأكسدة الكلية لم تتاثر باضافة الزنك الى العليقة. معاملة المجموعات المختلفة بالزنك سواء العضوي أو غير العضوي لم تؤثر على قطعيات الذبيحة ونسبة التصافى فى الحملان .وخلصت الدراسه ان اضافة الزنك فى صورته الغير عضويه او العضويه انها تحسن من اداء الحملان النامية .

Table (1): Chemical composition of concentrate mixture and wheat straw

Item	Concentrate mixture	Wheat straw
Dry Matter	91.5	86.84
Crude Protein	13.3	4.56
Crude Fiber	10.1	35.23
Fat	4.4	2.48
Ash	11.8	16.09
Nitrogen Free Extract	51.9	41.64
Zn/mg/kg DM	39.5	10

Table (2): Growth Performance of lambs fed different sources of zinc.

Item	Treatment			P-value
	Control	Zn-So4	Zn-Meth	
Initial Weight	26.5 ± 3.27	26 ± 3.48	27.3 ± 3.1	0.95
Final Weight	44.75 ± 2.39	47 ±1.58	49.2 ± 2.56	0.42
BW gain (kg)	18.25 ± 2.46	21 ± 2.67	21.9 ± 2.15	0.56
Daily gain (g)	99.73^{b} ± 13.45	132.21^{a} ± 0.47	130.96^{a} ±4.71	0.04
Feed intake (FI,g/day)				
DMI of concentrate	710	710	710	---
DMI of roughage	108.75 ± 18.39	122.75 ± 11.01	144.2 ± 14.3	0.27
Total DM intake	818.75 ± 18.39	832.75 ± 11.01	854.2 ± 14.33	0.27
TDN Intake	478.96^{b} ±10.75	519.05^{ab} ± 6.87	547.79^{a} ± 9.19	0.01
SV intake	467.50^{b} ± 0.50	506.56^{ab} ± 6.70	535.33^{a} ± 9.98	0.01
DCP Intake	64.27^{b} ± 1.44	71.70^{a} ± 0.95	72.52^{a} ±1.22	0.01
Feed conversion ratio (g/g gain)				
DM	8.77 ± 1.40	6.42 ± 0.54	6.55 ± 0.25	0.13
TDN	5.13 ± 0.82	4.00 ± 0.34	4.20 ± 0.16	0.23
SV	5.00 ± 0.80	3.91 ± 0.33	4.11± 0.15	0.24
DCP	1.56 ± 0.24	1.85 ± 0.17	1.81 ± 0.07	0.37

a, b, c, Means of the same column in each item with different superscripts are significantly different (P<0.05).
ZnSO4: Zn sulphate , 20 mg/head/day
Zn-Meth: Zn-methionine, 20 mg/head/day.

Table (3): The effect of zinc source on some blood metabolites.

Item	Treatment			P-value
	Control	Zn-So4	Zn-Meth	
Total Protein g/dl	5.97 ± 0.22	5.86 ± 0.17	6.16 ± 0.16	0.48
Albumin g/dl	2.64 ± 0.10	2.62 ± 0.06	2.56 ± 0.06	0.70
Globulin g/dl	3.34 ± 0.16	3.23 ± 0.15	3.61 ± 0.17	0.24
Glucose mg/dl	52.74 ± 1.41	50.76 ± 1.85	50.75 ± 1.97	0.68
Cholesterol mg/dl	41.54^{b} ± 1.17	47.64^{a} ± 1.12	47.00^{a} ±1.30	0.01
Triglycerides mg/dl	26.51 ± 1.54	29.66 ± 1.45	28.99 ± 1.22	0.27
Zinc µg/ml	1.11^{b} ± 0.06	1.31^{b} ± 0.06	2.13^{a} ± 0.16	0.01
TAC mmol/L	1.68 ± 0.10	1.73 ± 0.20	1.58 ± 0.15	0.77

a, b Means of the same column in each item with different superscripts are significantly different (P<0.05).
ZnSO4: Zn sulphate , 20 mg/head/day
Zn-Meth: Zn-methionine, 20 mg/head/day.

Table (4): Effect of feeding different source of Zinc to lambs on hot carcass and edible and non-edible parts.

Items	Treatment			P-value
	Control	Zn-So4	Zn-Meth	
Slaughter Weight (kg)	44.50 ± 3.62	53.33± 1.86	55.33 ± 3.84	0.11
Hot carcass(kg)	42.50^{b} ± 3.33	50.83^{ab} ±1.92	53.67^{a} ± 3.67	0.05
Dressing Percentage, %	50.73 ± 3.13	52.47±1.24	52.00 ± 1.36	0.42
Right side (kg)	10.47 ± 1.31	13.12 ± 0.31	13.48 ± 0.97	0.13
Left side (kg)	10.98 ± 1.73	13.33 ± 0.30	13.75 ± 0.87	0.25
Feet (kg)	1.14 ± 0.08	1.44 ± 0.15	1.37 ± 0.02	0.16
Head (kg)	2.84^{b} ± 0.04	3.23^{a} ± 0.14	3.28^{a} ± 0.06	0.03
Caul Fat (gm)	186.00 ± 5.03	326.33 ± 133.45	382.40 ± 241.54	0.69
Tail (kg)	2.35 ± 0.32	4.55 ± 1.64	3.90 ± 0.70	0.37
Kidney (gm)	108.00 ± 3.06	108.67 ± 4.67	377.33 ± 0.27	0.43
Kidney Fat (gm)	0.543 ± 0.150	0.523 ± 0.187	0.243 ± 0.08	0.33
Heart (gm)	182 ± 15.0	234 ± 17.0	207 ± 13.2	0.14
Heart Fat (gm)	386.67 ±132.83	586.7± 185.2	553.33 ±104.1	0.60
Lungs (kg)	0.61 ± 0.04	0.67 ± 0.05	0.73 ± 0.07	0.33
Sex Organs, kg	0.52 ± 0.14	0.46 ± 0.01	0.63 ± 0.04	0.40
Pelt (kg)	4.69^{b} ± 0.65	4.52^{b} ± 0.14	7.30^{a} ± 0.75	0.02
Spleen (gm)	71.33 ± 9.82	88.00 ± 3.46	77.33 ± 2.91	0.24

$^{a, b}$ *Means of the same column in each item with different superscripts are significantly different (P<0.05).*
ZnSO4: Zn sulphate , 20 mg/head/day
Zn-Meth: Zn-methionine, 20 mg/head/day.

Table (5): Effect of feeding different source of Zinc to lambs on carcass left side and its components of lambs.

Item (kg)	Treatment			P-value
	Control	Zn-So4	Zn-Meth	
Left Side	10.98±1.73	13.33±0.30	13.75±0.87	0.25
Neck	1.34±0.24	1.50±0.13	1.48±0.10	0.77
Shoulder	2.11±0.29	2.73±0.01	2.66±0.29	0.21
1- 6 Ribs	1.10±0.43	1.24±0.17	0.98±0.07	0.80
7 – 12 Ribs	0.86±0.13	1.11±0.08	1.34±0.21	0.15
Rack breast	1.17±0.27	1.32±0.36	1.71±0.13	0.41
Loin	1.50±0.29	1.21±0.02	1.55±0.10	0.41
Legs	3.85±0.31	3.79±0.03	4.19±0.28	0.50
Tail	2.35±0.32	4.55±1.64	3.90±0.70	0.37

ZnSO4: Zn sulphate , 20 mg/head/day
Zn-Meth: Zn-methionine, 20 mg/head/day.

Table (6): Effect of feeding different source of Zinc on chemical analysis of longissimus muscle of lambs.

Item	Treatment			P-value
	Control	Zn-So4	Zn-Meth	
Moisture	28.73±0.61	30.024±1.50	28.95±0.22	0.78
Fat	9.69±2.89	11.23±1.55	6.79±1.09	0.37
Ash	3.97±0.33	3.73±0.19	3.93±0.39	0.91
Protein	56.36±2.47	58.07±2.83	54.45±1.28	0.62

ZnSO4: Zn sulphate, 20 mg/head/day
Zn-Meth: Zn-methionine, 20 mg/head/day.