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INFLUENCE OF DIETARY ORGANIC ZINC SUPPLEMENTATION ON BROILER CHICKS PERFORMANCE UNDER EGYPTIAN SUMMER CONDITION

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ABSTRACT

An experiment was conducted to evaluate the effect of dietary zinc- methionine supplementation as an organic source of zinc on growth performance (body weight, body weight gain, feed intake and feed conversion) and carcass characteristics of broiler chicks during hot summer season (28-32°C). A total number of 150 broiler chicks one week old were randomly distributed into five treatment groups of 30 chicks with three replicates each of 10 chicks per replicate. Chicks of all experimental groups had nearly the same average initial weight. The 1st group was fed the basal diet without supplementation as control. The 2nd, 3rd, 4th and 5th groups were fed the basal diet supplemented with zn-methionine to provide zinc at levels 20, 40, 60 and 80 mg zinc/kg diet, respectively. The experiment extended for 5 weeks. Results obtained could be summarized as follow: The heaviest live body weight and body weight gain values were recorded for birds fed diet supplemented with 80 mg zinc-methionine/ kg diet. During the finisher period (3-5 weeks of age) and the whole experimental period (1-5 weeks of age), feed intake was increased and feed conversion rate was improved ($P \leq 0.05$) in chicks fed diets supplemented with zinc-methionine, compared to control. Results revealed that the relative weights of carcass traits were not significantly affected by adding the different zinc-methionine levels in the diet. In conclusion, the present results indicated that, through the hot summer of Egypt, the best performance of broiler chicks could be obtained by supplementing broiler diets with 80 mg zinc-methionine/kg diet as an organic source of zinc.

Key words: Broiler, organic, zinc, summer, growth, performance, carcass.

INTRODUCTION

High ambient temperature is a problem in many parts of the world. Heat stress has been associated with decreases in broiler weight gain, feed intake, feed efficiency, N retention, protein digestibility, and total mineral retention (Austic, 1985; Sahin and Kucuk, 2003). Environmental stress has been shown to elevate lipid peroxidation products in serum and liver, and to decrease serum and tissue levels of antioxidant vitamins in poultry (Sahin and Kucuk, 2003). Increased mineral excretion is one of the important consequences of heat distress. Belay and Teeter (1996) reported lower rates of phosphorus, potassium, sodium, magnesium, sulfur, manganese, copper, and zinc retention in broilers raised at high cycling ambient temperatures (24 to 35°) compared with birds housed at 24°C. High temperatures affect availability of minerals, and body weight gain is seriously compromised (Smith *et al.*, 1995). Interactions among minerals and other nutrients are extensive and may be important in the determination of biological availability of other nutrients. Zinc retention by broilers exposed to heat stress is reduced with increased zinc excretion (Belay *et al.*, 1992; Belay and Teeter, 1996). Antioxidant vitamins and minerals such as vitamin C, E, A, and Zn have been used to ameliorate the effects of environmental stress (Sahin and Kucuk, 2003). Supplemental zinc is used in poultry diets and is reported to be of benefit to laying hens during environmental stress (Sahin and Kucuk, 2003).

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The mechanism by which zinc exerts its antioxidant action is not well defined. However, it has been suggested that zinc increases the synthesis of metallothioneine which acts as a free radical scavenger (Bales *et al.*, 1994 ; Close, 1999). Zinc is an essential component of both DNA and RNA polymerase enzymes and is vital to the activity of variety hormones including glucagon insulin, growth and sex hormones. Zinc is an integral part of more than 300 enzyme systems that are involved in metabolism of energy, carbohydrates, nucleic acids and protein. Moreover, zinc plays a key role in the immune system, transport and use of vitamin A (Ibs and Rink, 2003).

Published research relative to the interactions between heat stress and zinc picolinate (ZnPic) in poultry is sparse. Adverse effects of heat stress on zinc metabolism are becoming increasingly important as environmental concerns arise about excess zinc excreted in poultry manure.

Organic zinc sources such as Zn-methionine or Zn-propionate were more bioavailable than inorganic zinc sources such as ZnO or $ZnSO_4\_H_2O$ (Spears, 1989; Wedekind *et al.*, 1992; Hahn and Baker, 1993; Rahman *et al.*, 2002).

Therefore, this study aimed to investigate the influence of zinc- methionine supplementation on growth performance and carcass traits of broiler chicks under Egyptian summer conditions.

MATERIALS AND METHODS

The present experiment was carried out at private poultry farm, Al Qalubia Governorate, Egypt. The experimental design was completely randomized, composed of 5 treatments and 3 replications. A total number of 150 broiler chicks one week old were randomly distributed into five treatment groups of 30 chicks with three replicates each of 10 chicks per replicate. Chicks, of all experimental groups had nearly the same average initial body weight. The 1st group was fed the basal diet without supplementation as control. The 2nd, 3rd, 4th and 5th groups were fed the basal diet supplemented with zinc methionine to provide zinc at levels 20, 40, 60 and 80 mg zinc/kg diet, respectively.

The basal experimental diet was formulated to cover the nutrient requirements of broiler chicks from 1 to 5 weeks of age according to NRC (1994). The same basal diet was fed without or with supplementation of zinc-methionine to provide zinc at levels 20, 40, 60 and 80 mg/ kg diet. The composition and calculated analyses of the experimental basal diet are presented in Table 1. All chicks were floor brooded and were reared under the same managerial and hygienic conditions. Feed and water were supplied *ad libitum*. Chicks were individually weighed at 1, 3 and 5 weeks of age. Feed consumption was recorded weekly until marketing age on a replicate basis. Consequently, body weight gain and feed conversion (g feed/g gain) were estimated during each experimental period (1-3, 3-5 and 1-5 weeks of age). At 5 weeks of age, a slaughter test was performed. Three birds from each group were randomly selected, fasted overnight and weighed then slaughtered by a sharp knife to complete bleeding then followed by plucking the feather and finally weighed. The carcass traits studied were giblets (liver, gizzard and heart), carcass and dressing percentage.

Data were subjected to analysis of variance procedures appropriate for a completely randomized design using SPSS® software statistical analysis program (SPSS, 1999). Duncan's new multiple range test (Duncan, 1955) was used for comparison among significant means.

RESULTS AND DISCUSSION

Growth Performance

Live body weight and daily body weight gain

Live body weight and daily body weight gain of broilers as affected by zinc-methionine supplementation in the diets are presented in Tables 2 and 3. Concerning live body weight, the results indicated that the average initial live body weight at one week old of different groups were nearly similar. This created suitable condition to appraise the effect of zinc supplementation on the performance of experimental chicks. At 3 weeks of age, no significant variations were found in live body weight due to supplementation of different levels of zinc-methionine in the diet.

Table 1. Composition and calculated analyses of the basal diets

Items	Basal diets	
	Starter (1-3 wks)	Finisher (3-5 wks)
Ingredients (%)		
Yellow corn	57.03	60.49
Soybean meal (44%)	31.65	27.15
Corn gluten meal	6.50	6.10
Di calcium phosphate	1.70	1.50
Limestone	1.24	1.15
Vit-min premix*	0.30	0.30
NaCl	0.30	0.30
DL-Methionine	0.15	0.01
L-Lysine Hcl	0.13	0.15
Soybean oil	1.00	2.85
Total	100	100
Calculated analyses**		
CP (%)	23.05	21.05
ME Kcal/kg diet	2951	3100
Ca (%)	1.00	0.90
P (Available) (%)	0.45	0.40
Lysine (%)	1.20	1.10
Meth.+Cyst. (%)	0.93	0.73
CF (%)	3.55	3.31

* Growth vitamin and mineral premix each 2.5 kg consists of : Vit A 12000, 000 IU; Vit D3, 2000, 000 IU; Vit. E. 10g; Vit k3 2 g; Vit B1, 1000 mg ; Vit B2, 49g ; Vit B6, 105 g; Vit B12, 10 mg; Pantothenic acid, 10 g; Niacin, 20 g , Folic acid , 1000 mg ; Biotin, 50 g; Choline Chloride, 500 mg, Fe, 30 g; Mn, 40 g; Cu, 3 g; Co, 200 mg; Si, 100 mg and Zn , 45 g.

** Calculated according to NRC (1994)

Table 2. Live body weight ($\overline{X}$ ±SE) of broiler chicks as affected by organic zinc levels.

Organic Zn level (mg/kg diet)	Live body weight (g)		
	1 week	3 weeks	5 weeks
0.00	138.33± 0.17	710.67± 12.67	1376.67^{c} ± 18.56
20.00	138.67± 0.33	699.33± 5.51	1414.00^{bc} ± 53.00
40.00	138.33± 0.17	703.67± 6.36	1500.33^{ab} ± 5.17
60.00	138.83± 0.167	703.00± 5.51	1516.00^{ab} ± 48.52
80.00	138.83± 0.167	729 .17± 2.45	1611.33^{a} ± 27.76
Sig.	NS	NS	* *

Table 3. Daily body weight gain ($\overline{X}$ ±SE) of broiler chicks as affected by organic zinc levels

Organic Zn level (mg/kg diet)	Daily body weight gain (g/day)		
	1-3 weeks	3-5 weeks	1-5 weeks
0.00	40.88± 0.91	47.57^{c} ± 1.71	44.2^{c} ± 0.66
20.00	40.05± 0.38	50.05^{bc} ± 3.93	45.5^{bc} ± 1.9
40.00	40.38 ± 0.45	56.91^{ab} ± .27	48.6^{ab} ± 0.18
60.00	40.28± 0.40	58.07^{ab} ± 3.07	49.2^{ab} ± 1.73
80.00	42.17± 0.17	63.01^{a} ± 2.15	52.6^{a} ± 0.99
Sig.	NS	* *	* *

At 5 weeks of age, live body weight was significantly (P≤0.01) affected by different levels of dietary zinc-methionine supplementation. Results in Table 2 reveal that increasing dietary zinc-methionine supplementation to broiler diets increased (P≤0.01) live body weight at 5 weeks of age. However, live body weight was statistically similar for the chicks fed diet containing 40, 60 and 80 mg zinc-methionine/ kg diet. Also, live body weight was statistically similar for chicks fed diet without supplementation (control) and those fed diet containing 20 mg zinc-methionine/ kg diet. It is worth noting that live body weight at 5 weeks of age increased by 2.64, 8.24, 9.19 and 14.56% in broiler chicks fed diet contining 20, 40, 60 and 80 mg zinc-methionine/ kg diet, respectively compared with control (unsupplemented). Generally, the highest live body weight was recorded for birds having 80 mg zinc-methionine/kg diet when compared with control and other treatment groups (20, 40, 60 and 80 mg zinc-methionine/ kg diet).

Regarding to body weight gain, data in Table 3 summarized the influence of zinc-methionine supplementation in broiler chicks during the period from one week to 5 weeks of age. Results indicate that the average daily weight gain values followed the same trend observed by live body weight, whereas daily body weight gain values during finisher period (3-5 weeks of age) and the whole experimental period (1-5 weeks of age) were significantly (P≤0.01) increased by increasing dietary zinc-methionine supplementation gradually in the diet from 20 to 40, 60 and 80 mg/kg diet. While, daily body weight gain was not affected significantly due to dietary zinc-methionine supplementation through the starter period (1-3 weeks of age).

During the whole experimental period (1-5 weeks of age), daily body weight gain increased by 2.86, 9.05, 10.16 and 15.97 % in broiler chicks fed diet containing 20, 40, 60 and 80 mg zinc-methionine/ kg diet, respectively compared with control (unsupplemented). The crossponding values of daily body weight gain during the finisher period increased by 4.96, 16.41, 18.08 and 24.50 %, respectively. In conclusion, the heaviest live body weight and body weight gain values were recorded for birds fed diet supplemented with zinc methionine to provide 80 mg zinc/kg diet. This may be imputed to that Zn plays a major role in DNA synthesis, protein and carbohydrate metabolism (Lieberman *et al.*, 1963; Forbes, 1984). Also, it may be due to that zinc has numerous biological roles including cell division and multiplication (Rubin, 1972; Rubin and Koide, 1973), cell mediated immune response (Fraker *et al.*, 1977) and performance (Collins and Moran, 1999). Results obtained of live body weight and body weight gain in the present study are in agreement with those reported by Kidd *et al.* (1994) who postulated that zinc-methionine supplementation increased live body weight by 6 %. Earlier studies with Hess *et al.* (2001) and Aoe *et al.* (2006) have reported an improvement in growth performance when organic Zn was added to the diets of broilers. Liu *et al.* (2013) observed the positive effect of diet supplementation with Zn protienate on body weight gain of broilers. Feng *et al.* (2010) found that the addition of high

levels (90-120 mg) of Zn glycine to the basal diet had a beneficial effect on growth performance and immunological characteristics.

Abou El-Wafa *et al.* (2003) reported that supplementing broiler diets with commercial organic mineral products such as zinc-methionine significantly improved body weight, feed conversion compared with the control diet during 3-6 weeks of age or overall period.

There are conflicting reports on the influence of Zn on performance in stressed birds. Barlett and Smith (2003) reported that dietary Zn levels did not affect growth performance in broilers reared under heat stress temperature. Kucuk (2008) investigated the effect of Zn (30 mg/kg) and Mg supplementation on performance responses in heat-stressed quail and reported that live body weight gain was greatest with the combination of Zn and Mg supplementation. On the other hand, some investigators (Rossi *et al.*, 2007; Wang *et al.*, 2002; Salim *et al.*, 2012; Yalcinkaya *et al.*, 2012) have shown that dietary organic zinc concentration did not significantly affect body weight gain. The inconsistent effects of organic zinc on the growth performance of birds may be due to the amount of zinc presented in the basal diet (Leeson and Summers, 2005) or the presence of other dietary ligands like phytate and Ca, which form insoluble complexes with Zn and interfere with its absorption (Oberlease *et al.*, 1966).

Feed intake and feed conversion ratio

Feed intake and feed conversion ratio of broiler chicks as affected by dietary organic zinc (zinc-methionine) supplementation in the diet are presented in Tables 4 and 5.

Results in Table 4 show that feed intake was significantly ($P \leq 0.05$) affected by the levels of dietary zinc-methionine supplementation during all the experimental periods studied (1-3, 3-5 and 1-5 weeks of age). During the finisher period (3-5 weeks of age) and the whole experimental period (1-5 weeks of age), feed intake was increased ($P \leq 0.05$) in chicks fed diets supplemented with zinc-methionine. The increase in feed intake was associated with increasing zinc-methionine supplementation in broiler chick diets to provide levels of 20 to 40, 60 and 80 mg zn/ kg diet. It is worthy to note that during the whole experimental period, increasing dietary zinc-methionine supplementation from 40 to 60, 80 mg/ kg diet increased feed intake by 3.28, 3.55 and 8.85%, respectively as compared with unsupplemented (control). The crossponding values during 3-5 weeks of age (finisher period) the increases were 6.09, 5.97 and 13.84%, respectively.

It could be noticed that chicks fed diet supplemented with 80 mg zinc-methionine/kg diet recorded the highest feed intake value, while chicks fed unsupplemented diet recorded the lowest value of feed intake. These results are in consistent with the results reported by El Kaiaty *et al.* (2001) who concluded that zinc supplementation to broiler diets had a beneficial effect on broiler performance and feed cost. Sahin *et al.* (2005) reported that Zn-picolinate supplementation as an organic source of Zn (30 or 60 mg / kg diet) improved the feed intake in quails reared under heat stress temperature.

In same respect, Aoe *et al.* (2006) have reported an improvement in feed intake when organic Zn was added to the diet of broilers. Also Liu *et al.* (2011) found that supplementation of broiler diet with organic Zn at concentration of 60, 120 and 180 mg/ kg diet increased the average daily feed intake. Likewise, Liu *et al.* (2013) observed the positive effect of dietary supplementation with Zn proteinate on feed intake of broilers.

Moreover, Feng *et al.* (2010) found some beneficial effects when Zn glycine chelate, as a source of organic Zn, for broiler chicks was evaluated. The addition of high levels of Zn glycine (90-120 mg/ kg diet) to the basal diet had a beneficial effect on feed intake. On the other hand, some investigators reported that feed intake did not significantly affected by dietary organic Zn as reported by Rossi *et al.* (2007), Salim *et al.* (2011 and 2012) and Yalcinkaya *et al.* (2012).

With regard to feed conversion ratio, results in Table 5 show that feed conversion ratio during the different periods of the experiment was significantly ($P \leq 0.01$) affected by dietary organic zinc (zinc-methionine) supplementation in the diets. Results revealed that increasing dietary zinc supplementation significantly improved ($P \leq 0.01$) the feed conversion ratio values during the finisher period and the whole one.

Table 4. Feed intake ($\overline{X}$ ±SE) of broiler chicks as affected by organic zinc levels

Organic Zn level (mg/kg diet)	Feed intake (g/day)		
	1-3 weeks	3-5 weeks	1-5 weeks
0.00	$66.77^{b} \pm 1.31$	$123.38^{bc} \pm 1.55$	$95.07^{c} \pm 1.16$
20.00	$70.34^{a} \pm 1.59$	$115.28^{c} \pm 7.88$	$92.81^{c} \pm 3.85$
40.00	$65.19^{b} \pm 0.27$	$131.38^{ab} \pm 1.54$	$98.29^{ab} \pm .902$
60.00	$65.93^{b} \pm 0.49$	$131.21^{ab} \pm 5.25$	$98.57^{ab} \pm 2.52$
80.00	$65.36^{b} \pm 1.35$	$143.2^{a} \pm 3.18$	$104.3^{a} \pm 1.17$
Sig.	*	*	*

Table 5. Feed conversion ($\overline{X}$ ±SE) of broiler chicks as affected by organic zinc levels

Organic Zn level (mg/kg diet)	Feed conversion (g feed/g gain)		
	1-3 weeks	3-5 weeks	1-5 weeks
0.00	$1.63^{b} \pm .019$	$2.60^{a} \pm .065$	$2.15^{a} \pm .015$
20.00	$1.76^{a} \pm .054$	$2.26^{b} \pm .030$	$2.04^{b} \pm .012$
40.00	$1.61^{b} \pm .021$	$2.31^{b} \pm .017$	$2.02^{b} \pm .018$
60.00	$1.64^{b} \pm .026$	$2.26^{b} \pm .040$	$2.01^{b} \pm .029$
80.00	$1.55^{b} \pm .031$	$2.27^{b} \pm .035$	$1.98^{b} \pm .016$
Sig.	*	* *	* *

During the whole experimental period (1-5 weeks of age),feed conversion values were improved by 5.12, 6.05, 6.51 and 7.91% in chicks fed diet supplemented with 20, 40, 60 and 80 mg zinc-methionine/kg diet, respictively when compared with control. The crossponding values during the finisher period were 13.08, 11.15, 13.08 and 12.69 %, respectively. It could be noticed that the best feed conversion ratio values were recorded during the aforementioned period for birds fed the highest zinc-methionine level (80 mg/ kg diet). While, chicks fed on unsupplemented diet (control) had the poorest feed conversion ratio values. This could be attributed to the increase in body weight as a result to organic zinc supplementation in broiler chick diets. Also, zinc positively affects feed utilization through participating in the metabolism of carbohydrates, lipids and proteins (MacDonald, 2000).

Results obtained in the present study are in agreement with those reported by Ferket *et al.* (1992) who found that turkey toms fed diets supplemented with zinc-methionine exhibited an improve of feed conversion ratio. Abou El-Wafa *et al.* (2003) reported that supplementing broiler with commercial organic mineral products of zinc-methionine significantly improved feed conversion ratio compared with the control diet during 3-6 weeks of age or overall period.

In this connection, Sahin *et al.* (2005) found that a linear improvement in feed efficiency was reported in zinc-picolinate supplemented quail diet reared under heat stress conditions. Aoe *et al.* (2006) and Saenmahayak *et al.* (2010) found that supplementation of broiler chicks diet with organic zinc significantly improved feed conversion ratio.

By contrast, Rossi *et al.* (2007), Owens *et al.* (2009), Salim *et al.* (2012) and Yaclinkaya *et al.* (2012) reported that dietary organic Zn concentrations did not significantly affect feed conversion ratio of broiler chicks.

Carcass traits

Results of slaughter test (g/100 g body weight) of chicks fed diet supplemented with zinc-methionine are presented in Table 6.

From Table 6, it was observed that the relative weights of carcass, giblet, dressing, heart, liver, gizzard, blood, feather and abdominal fats were not significantly affected by adding the different zinc-methionine levels in the diet. However, the highest values of relative weights of carcass, dressing and abdominal fat were recorded by birds fed diets containing 80 mg zinc-methionine/ kg diet compared with the relative weights of control. It surpassed the control (unsupplemented diet) by 2.40, 2.53 and 26.34 % for relative weights of carcass, dressing and abdominal fat, respectively.

The results were in a good agreement with Abou El-Wafa *et al.* (2003) who reported that dietary zinc-methionine supplementation did not affect carcass characteristics (percentages of dressing, liver, heart, gizzard and abdominal fat). Sahin *et al.* (2005) reported that dietary Zn-picolinate supplementation (30 or 60 mg/kg) improved carcass weight in quails reared under heat stress temperature. The obtained results disagreed with Rossi *et al.* (2007) and Salim *et al.* (2012) who have shown that carcass yield were not significantly affected by the addition of organic zinc.

In conclusion, the results of this study indicated that, through the hot summer of Egypt, the best performance of broiler chicks could be obtained by supplementing 80 mg zinc-methionine/kg diet as an organic source of zinc.

Table 6. Carcass traits ($\overline{X}$ ±SE) of broiler chicks as affected by organic zinc levels

Organic Zn level (mg/kg diet)	Carcass traits									
	Pre-slaughter weight	Carcass (%)	Giblet (%)	Dressing (%)	Heart (%)	Liver (%)	Gizzard (%)	Blood (%)	Feather (%)	Fat (%)
0.00	1390.00^{c} ±20.81	69.99	5.41	75.40	0.43	2.96	2.02	2.97	3.30	1.65
20.00	1451.67^{bc} ±56.29	70.98	5.68	76.65	0.52	3.02	2.14	2.87	3.47	1.71
40.00	1520.00^{b}±15.27	71.58	5.31	76.89	0.43	2.76	2.13	2.76	2.88	1.99
60.00	1540.00^{ab} ±45.09	70.85	5.11	75.96	0.45	2.31	2.35	3.27	3.29	1.37
80.00	1641.67^{a} ±27.73	71.71	5.64	77.36	0.46	2.93	2.25	3.31	2.83	2.24
Sig	* *	NS	NS	NS	NS	NS	NS	NS	NS	NS

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تأثير إضافة الزنك العضوي للغذاء على أداء كتاكيت اللحم تحت ظروف الصيف المصرية

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تم إجراء هذه التجربة لدراسة تأثير استخدام الزنك مثيونين كمصدر من مصادر الزنك العضوي علي الأداء الإنتاجي (وزن الجسم – الزياده الوزنيه – الغذاء المأكول – معامل التحويل الغذائي) ومواصفات الذبيحة لدجاج اللحم أثناء فصل الصيف الحار (٢٨ – ٣٢° م)، أجريت الدراسة على عدد ١٥٠ كتكوت دجاج لحم عمر أسبوعاً واحداً وتم توزيعهم عشوائيا علي خمس مجموعات كل مجموعه تضم ٣٠ كتكوت مقسمة علي ٣ مكررات كل مكرر يشمل١٠ كتاكيت وكان وزن الكتاكيت عند بداية التجربة لكل المجموعات ثابتا، لهم نفس متوسط الوزن تقريباً، تم تغذية المجموعة الأولى على عليقه أساسية بدون إضافة الزنك لتمثل مجموعة الكنترول، والمجموعات الثانية والثالثة والرابعة والخامسة تم تغذيتها علي العليقة الأساسية مضاف إليها الزنك مثيونين لتحقيق مستويات ٢٠ و٤٠ و٦٠و٨٠ ملليجرام زنك / كجم عليقه بالترتيب وقد استمرت التجربة لمده ٥ أسابيع، النتائج المتحصل عليها يمكن تلخيصها في الاتي : سجلت أعلى أوزان وأفضل زيادة وزنية للطيور المغذاة مع إضافة ٨٠ ملليجرام زنك مثيونين/ كجم عليقه خلال فترة الناهي من (٣- ٥) أسابيع وكذلك في الفترة من (١– ٥) أسابيع، وكذلك زاد الغذاء المأكول وتحسن معامل التحويل الغذائي في الدجاج المغذي علي العليقة المضاف لها الزنك مثيونين مقارنه بالكنترول، أشارت النتائج إلى أن استخدام المستويات المختلفة من الزنك مثيونين لم تعطي فروق معنوية في نتائج مواصفات الذبيحة، ونخلص إلى أن نتائج هذه الدراسة أثناء الجو الحار في مصر أثبتت أن أفضل أداء كان عند إضافة ٨٠ ملليجرام زنك مثيونين / كجم علف كمصدر للزنك العضوي.

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