Effects of Dietary Zinc Supplementation on Growth Performance, Carcass Characteristics And Some Blood Parameters of Broiler Chicks

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(Received December 20, 2004)

ABSTRACT

This study was carried out to determine the effects of supplemented 4 levels of zinc (Zn) as zinc sulphate ($ZnSO_4.7H_2O$) in broiler diets on performance, carcass characteristics, some blood parameters and economic efficiency of broilers. Two hundred, one-day old male broiler (Arbor Acres) chicks were used and randomly assigned to 5 groups.The birds were fed either a control diet or the control diet supplemented with either 50,100,150 or 200 mg Zn/kg diet. The experiment lasted 7 weeks.The results obtained can be summarized as follows:

Significant increases in final body weight and total body weight gain (0-7 wks) were observed in groups received 50 and 100 mg Zn/kg diet compared to the control group, and the other treated groups. However there were significant decreases in total body weight gain in groups received 150 and 200 mg Zn/kg diet compared to the control group. A significant decrease in total feed consumption was observed in groups received 150 and 200 mg Zn/kg diet compared to the control group and the other treared groups during the whole experimental period (0-7 wks). Feed conversion efficiency for the whole experimental period (0-7 wks) was improved significantly of groups received Zn supplemented diets 50, 100 and 150 mg/kg diet compared to the control group.

Data of carcass characteristisics showed non significant differences between the treated groups which received Zn supplemented diet as compared to the control group concerning liver weight, heart weight and empty gizzard weight. Significant decreases ($P\leq 0.05$) were observed in abdominal fat weight and percentages in all groups which recevied Zn supplemened diet compared to the control group.Carcass weights were significantly increased of groups recevied 50 and 100 mg Zn/kg diet compared to the control group. Also, there were significant increases ($P\leq 0.05$) in carcass percentages in all groups which recevied Zn supplemened diet compared to the control group. Zinc supplementation to broiler diets depressed both bursa and thymus (weights and percentages) and increased spleen weight and percentage in all treated groups compared to the control group.

Plasma total protein was significantly increased of groups recevied 100 and 200 mg Zn/kg diet compared to the control group. Also, plasma albumin was significantly increased ($P\leq 0.05$) in all groups which received Zn supplemented diet compared to the control group. The obtained data revealed significant increase in plasma globulins of group recevied 100mg Zn/kg diet compared to the control group. The data obtained for plasma creatinine, total lipid and triglyceride revealed significant increases ($P\leq 0.05$) in all groups which received Zn supplemented diet compared to the control group. While plasma albumin-globulin ratio and total cholesterol showed non significant differences in all treated groups which received Zn supplemented diet as compared to the control group.

The data showed non significant differences between all treated groups which received Zn supplemented diets in number of red blood cells, hemoglobin, mean corpuscular volume and packed cell volume compared to the control group. Meanwhile, there was a significant increase in white blood cells in all groups which received Zn supplemented diets as compared to the control group.

Supplementing zinc to control diet at levels of 50 and 100 mg/kg diet improved economic efficiency (EE) as compared to the control group. These improvement in EE were 6.92 and 7.19 % than the control value respectively.

These results indicate that supplementing zinc at levels 50 and 100 mg Zn/kg diet were more effective for improving growth performance and economic efficiency, increasing carcass weight and percentages and reducing abdominal fat than the control. However adding 50mg Zn/kg diet would be recommended as a suitable supplemental level to broiler diets.

Key words: Broilers, Dietary Zinc, Growth Performance, Carcass Characteristics, Blood Parameters

INTRODUCTION

Zinc is essential trace element that was found to be of biological importance as a component of many enzymes and an activator of others. Enzymes requiring Zn are involved in nucleic acid, protein and carbohydrate metabolism and basic functions in growth performance (Mohanna *et al.*, 1999 and Underwood and Suttle, 1999). Zinc also is important for normal immune system development, wound healing and maintaining insulin function (Sullivan *et al.*, 1998). It plays a critical role as an antioxidant and may be involved in the antioxidant defense system as an integral part of body cells (Oteiza *et al.*, 1995).

Today, zinc is a popular supplement used for human and animals as an effective antioxidant, reducing incidence of diseases such as pneumonia and diarrhea by enhancing immunity as well as growth of infants (Manning, 1999) and young animals (Underwood and Suttle, 1999). The recommended requirement of zinc is 40-70 ppm for poultry (NRC,1994). The maximum tolerable level stated by the NRC (1980) is 500 ppm for most poultry. The most widely used products of zinc supplementation are zinc oxide, zinc sulphate and zinc methionine (Underwood and Suttle, 1999).

Poultry diets are often supplemented with zinc above the amount recommended by the National Research Council, in order to "assure" optimal performance (NRC 1984). However, excess zinc has been shown to cause gizzard erosion and growth reduction in chicks and laying hens, while zinc deficiency is characterized by subnormal growth, decreased appetite, poor feed conversion and parakeratosis (Dewar, *et al.*, 1983 and McDonald *et al.*, 1980).

Therefore, the objective of this study was to evaluate the effects of zinc (zinc sulphate) supplementation in diets at various levels on growth performance, carcass characteristics, some blood parameters and ecnomic efficiency of broiler chicks.

MATERIALS AND METHODS

Birds:

Two hundred,one-day old Arbor Acres male broiler chicks used for this study were obtained from Ismailia Misr Poultry Company. Birds were housed in brooder batteries with wire floors at the Poultry Experimental Farm, Faculty of Agriculture, Suez Canal University. Chicks were weighed, wing banded and randomly allotted to 5 groups. Within each group 40 chicks were divided randamly to four replicates of 10 chicks each. Diet and water were provided *ad-libitum*. Photoperiod was maintained at 24 hours light throughout the study which lasted 7 weeks. Individual body weights and feed consumption per replicate were recorded weekly to calculate feed conversion efficiency (g feed consumed/g weight gain).

Experimental diets

Three types of basal diet were formulated to meet the nutritional requirements suggested by NRC (1994). The starting diet (0-3 wks) containing 23%crude protein and 3200 Kcal ME/kg diet,followed by a growing diet (3-6 wks) containing 20% and 3200 Kcal ME/kg diet, followed by finishing diet (6-7 wks)containing 18% crude protein and 3200 Kcal ME/kg diet. The diet composition and its chemical analysis are shown in (Table 1). Dry matter, crude protein (Kjeldahl N X 6.25), crude fiber, ether extract, and ash were analyzed using the standard methods of the Association of Official Analytical Chemists (AOAC, 1995). Zinc was in the form of powdered salt of zinc sulphate ($ZnSO_4.7H_2O$). In this experiment, four levels of zinc sulphate were supplemented to the basal diet. The highest dose of zinc was calculated as 40% of the tolerable dose (500 mg Zn/kg). The four supplementary levels used were 219.78, 439.56, 659.34 and 879.12 mg of $ZnSO_4$/kg diet, equivalent to 50,100,150 and 200 mg Zn/kg diet.

Experimental Design

Five experimental groups were used in this study, the first group was the control in which the chicks were fed the basal diet without Zinc supplementation. Groups 2, 3, 4 and 5 were fed the basal diet supplemented with $ZnSO_4$ of the aforementioned levels from one-day to 7 wks of age.

Carcass characteristics

At the end of the experiment (7 weeks old) five males were taken randomly from each group for slaughter test.Weights of eviscerated carcass, liver, heart, empty gizzard, abdominal fat, and lymphoid organs (bursa, thymus and spleen) were recorded to the nearest gram. Abdominal fat, eviscerated carcass, and lymphoid organs were calculated as a percentage of live body weight.

Hematological and biochemical parameters

At 7^{th} weeks of age, blood samples were collected from five males in each group. Blood samples were collected from brachial veins into heparinzed tubes. Part of blood samples was used for hematological analysis including total red blood cells (RBCs) and white blood cells (WBCs) count according to the method of Miller and Seward (1971). Determination of hemoglobin (Hb) was carried out according to the method of Schalm,*et al.*, (1975). Packed cell volume (PCV%) and mean corpuscular volume (MCV) were calculated. Another part of blood was centrifuged at 3000 rpm for 10 min.to separate plasma. Plasma samples were stored at $-20^{o}C$ until used for determination of total protein (Peter, 1968), albumin, (Doumas *et al.*, 1971), creatinine (Husdan,1968),total lipids (Zollner and Kirsch, 1962) triglycerides (Fossati and Prencipe 1982), and cholesterol (Waston,1960) by using available commercial kits (Bio-Merieux, France). The globulin values were obtained by subtracting the values of albumin from the corresponding values of total protein (Coles,1974). Also albumin/globulin ratio (A/G) was calculated.

Economical Efficiency

At the end of this work, the economical efficiency of the product was, calculated from the input-output analysis based upon the differences in both growth rate and feeding cost as described by Bayoumi (1980).

Statistical Analysis

The data of body weight, body weight gain, feed consumption, feed conversion efficiency, slaughter test and blood parameters were statistically analyzed using one-way analysis of variance using SAS computer program (SAS, 1986). Differences among treatment means were tested using Duncan's Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Body weight

The effect of supplementing different levels of zinc on weekly body weight of broilers chicks are shown in Table (2). No significant difference ($P \leq 0.05$) was observed in body weight at 1st week of age between the treated groups with zinc supplementation and the control group, as well as among treated groups. Starting from 2 nd week of age and continued till 7th week of age, there were significant increases ($P \leq 0.05$) in body weight in groups recieved Zn supplemented diet with 50 and 100 mg/kg diet compared to the control group. On the other hand, group received 150 mg Zn/kg diet showed less body weights than the control but differences were not significant ($P \leq 0.05$) at the same periods, except in the 4th week the differense was significant. Starting from 3rd week till 5th of age, there were significant decreases ($P \leq 0.05$) in body weight in group which received the high level of zinc supplementation (200 mg Zn/kg diet) as compared to the control group.

These results are in agreement with those reported by Abou El-Wafa *et al.*, (2003), who reported that increasing the level of zinc up to 120 mg/kg diet of unsexed (Arbor Acres) broiler chicks caused significant improvement in body weight. Manning,(1999) indicated that using of Zn supplementation in diets at levels higher than that of basal requirement, as an initiative growth factor, is directly related to the improvement in growth rate. This is attributed to the need of Zn by a large number of enzymes as well as by the growth hormone. Similar results were observed in the findings of El-Kaiaty *et al.*, (2001), who reported that the level of 50 mg Zn/kg diet gave the best results in chick performance. Mohanna and Nys (1999) observed that a dietary zinc concentration of 45mg/ kg was sufficient to obtain normal broiler performance at 21 day of age. The observed increase in body weight due to supplementing Zn explained the benefical effect of Zn on supporting physiological functions required for physical performance as reported by Lukaski (1996). Also Zn plays a major role in protein metabolism (Forbes, 1984), DNA synthesis (Lieberman *et al.*, 1963), carbohydrate metabolism, and basic functions in growth performance (Mohanna *et al.*, 1999). On the contrary, Yi-Z *et al.*, (1996), Bartov (1996) and Abou Zeid *et al.*, (1999) reported that Zn supplementation had no effect on body weight. Also, Zhu *et al.*, (1997) reported negative correlation (-0.3319) between dietary zinc and body weight.

The present results suggest that Zn supplementation at levels of 50 and 100 mg/ kg diet tended to improve body weight as compared to the control and the other experimental levels (150 and 200 mg / kg diet).However, the most level of choice of zinc is 50 mg Zn/kg diet which can be recommended as a suitable supplemental level to broiler diets. These results run parrallel with the previous data of Wu-XiuYun, *et al.*, (1996) who concluded that the optimum zinc concentration was 83.15 mg/kg in diets for broilers of 0-2 weeks old.

It was also found that present results support the results previously reported by Mohanna and Nys (1999) who found that when the dietary Zn content was decreased from 190 to 65 mg/kg, body Zn retention was increased from 8% to 20% and Zn concentration in broiler manure was reduced by 75%. In addition lowering dietary Zn supplementation reduced the risks of phytotoxicity in the soil resulting from excessive Zn concentration in manure.

Body weight gain

Weekly means of body weight gain are shown in Table (3). No significant difference ($P \leq 0.05$) was observed in body weight gain in treated groups which recevied Zn supplemented diet during the periods (0-1 wks) and (4-5 wks) of age as compared to the control group. While, there were significant increases in body weight gains in groups received 50 and100 mg Zn/kg diet during the periods (3-4 wks), (6-7 wks) and (0-7 wks) of age as compared to the control group and the other treated groups.

During 2-3 wks of age, the highest value of body weight gain was recorded in group which received 50 mg Zn/kg diet. Also group received 100mg Zn/kg diet recorded the highest value of body weight gain during 5-6 wks of age as compared to the control group and the other treated groups. However, there were significant ($P \leq 0.05$) decreases in body weight gain in groups received 150 and 200 mg Zn/kg diet during the periods (1-2 wks), (3-4 wks) and (0-7 wks) of age as compared to control group. Regarding the whole experimental period (0-7 wks) there were significant ($P \leq 0.05$) increases in total body weight gain in groups received 50 and 100 mg Zn/kg diet. In addition there were significant ($P \leq 0.05$) decreases in total body weight gain in groups received 150 and 200 mg Zn/kg diet compared to the control group.

The observed increase in body weight gain of broiler chicks supplemented with Zn in the diets is in agreement with that reported by Kucuk *et al.*, (2003), who concluded that Zn supplementation at level 30 mg/kg diet significantly increased live body weight gain. Also, Mohanna and Nys (1999), reported that dietary zinc concentration of 45 mg/kg diet was sufficient to obtain normal broiler performance at 21 days of age. On the contrary, Kim and Patterson (2004) reported that broilers chicks fed diets supplemented with 1500 ppm Zn as $ZnSO_4$ were significantly lower in body weight gain than the control group.

Feed consumption

Data representing feed consumption are shown in Table (3). No Significant ($P \leq 0.05$) differences were observed in feed consumption between the experimental groups which received Zn supplemented diets at periods (0-1 wks), (4-5 wks) and the finishing period (6-7wks of age) as compared to the control group. While group which received 150mg Zn/kg diet showed a significant decrease in feed consumption as compared to the control and the other experimental groups during the periods (1-2 wks) and (5-6 wks) of age. In addition,there were significant decreases in feed consumption in groups received 150 and 200 mg Zn/kg diet as compared to the control and the other treated groups, during 3- 4 wks of age and the whole experimental period (0-7 wks). The present data showed that Zn supplementation to broiler diets at levels 50 and 100 mg/kg diet had no effect on total feed consumption, while levels more than 100 mg Zn/kg diet decreased feed consumption as compared to the control.

Sadoval *et al.*. (1999) and El-Kaiaty *et al.*. (2001) reported that high levels of dietary zinc above 50 ppm reduced feed consumption as compared to the control. In the same respect Abou-Zeid *et al.*, (1999) reported that treated group which received Zn supplementation at level 1000ppm were less in total feed consumption as compared to the control group. In addition, Kim and Patterson (2004) reported that broiler chicks fed the diet supplemented with 1500 ppm Zn as $ZnSO_4$ were significantly lower in feed consumption as compared to the control. Meanwhile, Mohanna and Nys (1999) found no differences in feed intake for zinc levels (14 and 35 mg/kg diet).

Feed conversion efficiency (FCE)

Data for FCE are shown in Table (3). No Significant ($P\leq 0.05$) differences were observed in FCE between the treated groups which received Zn supplemented diets as compared to the control group at periods (0-1 wks),(1-2 wks), (2-3 wks) and (5-6 wks) of age. While, FCE was improved significantly ($P\leq 0.05$) in groups received 100,150 and 200 mg Zn/kg diet during 4 -5 wks of age as compared to the control group. Groups received 50 and 100 mg Zn/kg diet showed a significant improvement ($P\leq 0.05$) in FCE during the finishing period (6-7 wks) of age compared to control and other experimental groups. However, groups which received 50,100 and 150 mg Zn/kg diet revealed a significant improvement ($P\leq 0.05$) in FCE during the periods (3-4 wks) and whole experimental period (0-7 wks) as compared to the control group. The present data showed that Zn supplementation to broiler diets at levels 50,100 and 150 mg/kg diet improved FCE. These results are in agreement with those of Abou El-Wafa *et al.*, (2003),who reported that in asing the level of supplemented Zn in broiler diet up to 120 mg / kg diet led to significant improvement in feed conversion. However, Abou Zeid *et al.*, (1999) reported that supplemented Zn in broiler diets at level 1000ppm as Zinc oxide showed better feed conversion as cmpared to the control. Also,Kucuk *et al.*, (2003)reported that Zn supplementation at level of 30mg /kg diet significantly improved feed efficiency.

On the contrary, Donmez *et al.*, (2002a),reported that adding Zn to drinking water at level of 125 mg Zn/L showed significantly lower feed efficiency. And Kim and Patterson (2004), reported that broiler chicks fed diet supplemented with 1500ppm Zn as $ZnSO_4$ were significantly lower in feed efficiency as compared to the control. In addition, Dozier *et al.*, (2003) reported that the Zn supplementation at levels from 40 to 120 mg/kg diet had no effect on body weight or feed conversion, but decreasing dietary Zn concentration from 120 to 40 mg/kg reduced Zn excretion by 50%, and can potentially decrease the accumulation of heavy metals in the enviroment without compromising bird performance.

The results suggested that Zn supplementation in broiler diets at levels 50,100 and 150 mg/kg diet improved feed conversion efficiency. It was cleared that the level of choice of Zn is 50mg Zn/kg diet which could be recommended as a suitable supplemental level to reduce the risks of phytotoxicity in the soil resulting from excessive Zn concentration in manure.

Carcass Characteristics

No significant differences were observed between the treated groups which received the Zn supplemented diet compared to the control group on liver weight, heart weight and empty gizzard weight (Table 4). Similar results were observed by Abou Zeid *et al.*, (1999), who reported that Zn supplementation had no effect on liver, heart and gizzard weights. Significant decreases ($P\leq 0.05$) were observed in abdominal fat weight and percentages in all groups which received Zn supplemened diet compared to the control group. Similar results were observed by Kucuk *et al.*, (2003). Carcass weights were significantly increased ($P\leq 0.05$) in groups received 50 and 100 mg Zn/kg diet compared to the control group. Also, there were significant increases ($P\leq 0.05$) in carcass percentages in all groups which received Zn supplemened diet compared to the control group. On the contrary Abou El-Wafa *et al.*, (2003), reported that dietary Zn as zinc oxide at levels 60,120, 180 mg/kg diet did not affect carcass characteristics.

Significant decreases ($P\leq 0.05$) were observed in bursa and thymus (weights and percentages) in all treated groups which received the Zn supplemented diets as compared to the control group. As well as significant increase in spleen weight and persentage in all treated groups which received the Zn supplemented diets as compared to control group. These results are in agreement with those of El-Kaiaty et al., (2001) who reported that Zn supplementation broiler diets depressed both bursa and thymus and increased spleen weight. On the contrary Abou Zeid *et al.*, (1999) reported that Zn supplementation at level 1000ppm as zinc oxide had significantly higher thymus and bursa weights in treated chicks as compared to the control group.

Blood parameters

The effects of zinc supplementation on blood parameters are shown in Table (5).The statistical analysis of blood parameters of broiler chicks showed a significant increase ($P \leq 0.05$) in plasma total protein in groups received 100 and 200 mg Zn/kg diet compared to the control group.These results are in agreement with those of Freeman, (1983), who reported important physiological role of Zn in protein synthesis and metabolism in poultry. Plasma albumin showed significant increases ($P \leq 0.05$) in all treated groups which received Zn supplementation in diets when compared to the control group. Groups which received 100 and 200 mgZn/kg diet recorded higher scores than the other treated groups. Zinc is essential for the antibodies production, the normal thymus gland function and the effectiveness of specialized lymphocytes called "helper cells" An optimal intake of Zn restores the compromised immune funtions and reduces the susceptibility of infection (Sherman, 1992).

The obtained data revealed a significant increase in plasma total globulin in group which received 100mg Zn/kg diet as compared to the control group (Table 5).The increase in plasma total globulin might be a reflection of the rise in plasma total protein. Kidd, *et al.*, (1996), confirmed that the improving effect of Zn on immunity by raising immunoglobulins.

Concerning albumin-globulin ratio, values showed non significant differences in all treated groups as compared to the control group. The lowest ratios attributed to the highest reactivity of immune response were recorded by the group received 100mg Zn/kg diet. These results agree with those report by Eversole, (1998). Meanwhile, plasma creatinine values obtained from treated groups which received the Zn supplemented diets revealed significant changes when compared with the control ones. These results agree with those reported by Bires *et al.*, (1993).

The data obtained for plasma total lipid revealed a significant increase ($P \leq 0.05$) in all groups which received the Zn supplemented diets as compared to the control group (Table 5). However, the findings achieved for Zn supplementation in the present study did not coincide with those of Jenkins and Kramer (1992), who showed that supplementation with 1000 ppm of Zn did not cause any arked quantitative changes in tissue lipids. Excess of Zn could be important in changing the structure and function of cell membranes and in the production of activity of prostanoids and leukotriences (Eder and Kirchgessner, 1994).

Concerning plasma triglyceride levels, a significant increase ($P \leq 0.05$) was found in all treated groups by Zn supplementation in comparison to the control. On the other hand, the increase in triglycerides concentration by Zn supplementation could be due to the increase in glucose availability as Zn is required for insulin secretion and storage (Somers and Underwood, 1969). Also glucose is essential for triglyceride synthesis because it forms alpha glycerophosphate which is the specific precursor of glycerol by which fatty acids are esterified for triglyceride formafion (Bergman,1983)

Regarding plasma total cholesterol, data showed non significant differences in all treated groups which received Zn supplemented diets as compared to the control ones. On the contrary, Kaya *et al.*, (2001) reported that adding 50 and100 mg Zn /kg diet increased total cholesterol level in laying hens.

Hematological parameters

The effect of Zn supplementation in diet on hematological parameters are shown in Table (6). The statistical analysis of data showed no significant differences in all treated groups received Zn supplemented diets in red blood cells count (RBCs), hemoglobin amount (Hb), mean corpuscolar volume (MCV) and packed cell volume (PCV) compared to control group. Meanwhile, there was a significant increase in white blood cells (WBCs) in all groups which received Zn supplemented diets as compared to the control group. These results are in agreement with those reported by Abou Zeid *et al.*, (1999). While Donmez *et al.*. (2002b), reported that there were no significant differences between the Zn supplemented groups and the control in erythrocyte count, hemoglogin amount and total leukocyte count.

Economic Efficiency (FE)

Economic evaluation study of broiler chicks fed the experimental diets are summarized in Table (7). Supplementing zinc to control diet at levels 50 and 100 mg/kg diet improved EE compared with the control group.These improvement in EE were 6.92 and 7.19% respectively than the control value. From economic point view, it was clear that group received 100 mg Zn/kg diet recorded the best EE. As well as group received 150mg Zn/kg diet recorded the lowest EE value as compared to the other Zn supplemented groups.

These results are in agreement with that reported by Abou Zeid *et al.*, (1999) and Abou El-Wafa *et al.*, (2003), they reported that Zinc supplementation to broiler diets may be beneficial to broiler's performance and economic efficiency.

In conclusion, these results provide evidence that supplementing zinc at levels 50 and 100 mg/kg diet were more effective for improving growth performance and economic efficiency, increasing carcass weight and percentages, reducing abdominal fat than the control. But it was cleared that the most level of choice of Zn is 50 mg Zn/kg diet would be recommended as a suitable supplemental level to broiler diets.

ACKNOLEDEGEMENT

The auther would like to express his great thanks to Prof. Dr Adel Siam, Department of Physiology, Faculty of Vet. Med., Suez Canal University for his

Table (1): Composition and chemical analysis of the experimental diets fed during starting, growing and finishing periods.

Ingredients (%)	Starter (0-3 wks)	Grower (3-6 wks)	Finisher (6-7 wks)
Yellow corn, ground	50.24	60.71	64.90
Soybean meal (44%)	33.00	25.70	26.03
Corn gluten	6.90	5.70	1.70
Sunflower oil	6.00	4.30	4.39
Dicalcium phosphate	1.70	1.40	1.01
Limestone	1.40	1.40	1.35
Sodium chloride	0.40	0.40	0.35
Vit. and Min. Premix*	0.25	0.25	0.25
DL- methionine	0.11	0.04	0.02
L- lysine	--	0.10	--
Chemical composition %			
Dry matter	85.80	86.30	85.30
Crude Protein	22.90	20.09	18.10
Crude fat	2.99	2.83	2.80
Crude fiber	3.70	3.42	3.40
Ash	6.04	5.52	5.20
Calculated composition			
ME(kcal/Kg)	3200.00	3200.00	3200.00
Crude Protein %	23.00	20.00	18.00
C/P ratio	139.13	160.00	177.77
Calcium %	1.00	0.91	0.81
Phosphorous, available %	0.45	0.38	0.31
Lysine %	1.10	1.01	0.89
Methionine %	0.51	0.39	0.32
TSAA %**	0.93	0.78	0.69
Price of ton diet (LE),2002	**961.64**	**877.30**	**819.07**

* Composition of the vitamins and minerals premix.
Each2.5 kg of vitamin and minerals mixture contain: 12,000,000 IU vitamin A; 2,000,000 IU D3'; 10g E; 1g K3; 1g BI; 5g B2; 1,500 mg B6; 10 mg B12; 10g pantothenic acid; 20g Nicotinic acid, 1g Folic acid; 50 mg Biotin; 500g choline chloride, 4g Copper, 300 mg Iodine; 30g Iron; 60g Manganese; and 100 mg Selenium.
**TSAA: Total sulfur amino acids

Table (2) Effect of supplementing different levels of zinc on weekly body weights for broiler chicks (Mean ± SE).

Weeks	Zn level mg/kg diet				
	0 (control)	50	100	150	200
0	46.88 ± 01.7^{a}	48.81 ± 1.8^{a}	48.82 ± 1.6^{a}	48.45 ± 1.8^{a}	46.92 ± 1.8^{a}
1	146.55 ± 4.02^{a}	150.50 ± 3.8^{a}	150.62 ± 3.1^{a}	144.15 ± 3.0^{a}	142.51 ± 3.0^{a}
2	350.84 ± 9.4^{b}	379.43 ± 9.0^{a}	378.55 ± 8.2^{a}	349.26 ± 6.4^{b}	346.11 ± 7.0^{b}
3	670.97 ± 14.1^{b}	728.84 ± 15.1^{a}	707.79 ± 15.8^{a}	661.09 ± 15.3^{bc}	641.56 ± 11.9^{c}
4	1010.97 ± 17.7^{b}	1123.50 ± 17.6^{a}	1099.97 ± 21.4^{a}	963.60 ± 22.2^{c}	945.20 ± 19.7^{c}
5	1401.17 ± 24.3^{b}	1519.46 ± 21.8^{a}	1489.72 ± 27.8^{a}	1374.06 ± 29.6^{bc}	1362.79 ± 26.4^{c}
6	1803.22 ± 31.2^{b}	1945.77 ± 24.6^{a}	1933.75 ± 35.8^{a}	1770.90 ± 36.7^{b}	1767.76 ± 36.3^{b}
7	2228.86 ± 37.4^{b}	2410.29 ± 39.5^{a}	2400.91 ± 45.4^{a}	2211.18 ± 49.0^{b}	2170.64 ± 50.9^{b}

a-c Means within the same row having different superscripts are significantly different ($P \leq 0.05$).

Table (3): Means of weight gain (WG) g, feed consumption (FC) g. and Feed conversion efficiency ratio (FCE) for the experimental chicks (mean ± SE).

Wks	Item	Zn level mg/kg diet				
		0	50	100	150	200
0-1	WG	99.67±5.15^{a}	101.69±6,13^{a}	101.80±6.10^{a}	95.70±4.50^{a}	95.59±4.37^{a}
	FC	123.81±6.48^{a}	126.10±6.12^{a}	126.57±6.33^{a}	118.25±5.90^{a}	118.08±6.03^{a}
	FCE	1.242±0.02^{a}	1.240±0.03^{a}	1.243±0.01^{a}	1.236±0.01^{a}	1.235±0.01^{a}
1-2	WG	219.29±7.35^{a}	228.93±11.22^{a}	227.93±5.91^{a}	205.11±7.20^{b}	203.60±4.24^{b}
	FC	314.08±9.83^{a}	321.94±6.97^{a}	323.79±9.21^{a}	287.20±3.58^{b}	314.89±9.07^{a}
	FCE	1.432±0.02^{a}	1.406±0.05^{a}	1.421±0.02^{a}	1.400±0.04^{a}	1.547±0.03^{a}
2-3	WG	320.13±7.76^{bc}	349.41±11.06^{a}	329.24±10.48^{b}	311.83±6.77^{c}	295.45±4.05^{d}
	FC	518.73±33.33^{b}	568.86±11.26^{a}	517.73±9.55^{b}	470.29±4.88^{c}	475.18±26.24^{c}
	FCE	1.620±0.06^{a}	1.628±0.08^{a}	1.573±0.04^{a}	1.508±0.026^{a}	1.608±0.03^{a}
3-4	WG	340.00±13.19^{b}	394.66±5.27^{a}	392.18±13.54^{a}	302.51±2.10^{c}	303.64±9.32^{c}
	FC	750.39±44.01^{a}	730.72±34.19^{a}	756.21±13.57^{a}	622.22±31.88^{b}	683.55±31.14^{b}
	FCE	2.207±0.07^{a}	1.852±0.08^{b}	1.928±0.06^{b}	2.057±0.102^{b}	2.251±0.13^{a}
4-5	WG	390.20±29.48^{a}	395.96±24.25^{a}	389.75±20.58^{a}	410.46±6.60^{a}	404.59±29.33^{a}
	FC	896.68±50.1^{a}	867.51±33.09^{a}	823.29±37.91^{a}	833.02±32.65^{a}	819.32±41.04^{a}
	FCE	2.298±0.13^{a}	2.191±0.13^{ab}	2.112±0.05^{b}	2.029±0.043^{c}	2.025±0.05^{c}
5-6	WG	402.05±30.83^{b}	426.31±18.04^{ab}	444.03±36.05^{a}	396.84±18.10^{b}	404.97±12.30^{b}
	FC	981.81±50.1^{b}	1062.25±26.4^{a}	1083.79±34.12^{a}	959.79±19.18^{c}	981.41±23.9^{b}
	FCE	2.442±0.12^{a}	2.492±0.08^{a}	2.441±0.13^{a}	2.419±0.057^{a}	2.423±0.07^{a}
6-7	WG	425.64±14.95^{bc}	464.52±12.13^{a}	467.16±15.29^{a}	440.28±15.71^{b}	402.88±22.50^{c}
	FC	1100.38±36.57^{a}	1135.44±34.41^{a}	1141.17±38.45^{a}	1115.52±32.85^{a}	1089.83±40.24^{a}
	FCE	2.585±0.14^{ab}	2.444±0.04^{c}	2.443±0.03^{c}	2.534±0.04^{b}	2.705±0.15^{a}
0-7	WG	2197.02±37.1^{b}	2361.48±30.4^{a}	2352.09±30.8^{a}	2162.73±21.6^{c}	2110.72±42.5^{c}
	FC	4685.89±65.03^{a}	4812.82±24.9^{a}	4772.55±47.7^{a}	4406.29±32.5^{b}	4482.26±97.1^{b}
	FCE	2.133±0.05^{a}	2.038±0.03^{b}	2.029±0.01^{b}	2.037±0.025^{b}	2.124±0.05^{a}

a - c Means within the same row having different superscripts are significantly different ($P \leq 0.05$).

Table (4): Effect of supplementing zinc on carcass characteristics of 7 wks old male broiler chicks (mean ±SE).

Items	Zn level mg/kg diet				
	0	50	100	150	200
Live body weight, g	2278.33±42.0^{b}	2441.67±28.1^{a}	2438.33±28.9^{a}	2241.67±11.6^{b}	2296.67±31.8^{b}
Liver weight, g	53.18±6.80^{a}	51.17±3.80^{a}	52.26±5.87^{a}	49.66±9.21^{a}	50.32±4.36^{a}
Heart weight, g	12.21±1.30^{a}	12.55±1.17^{a}	12.02±0.82^{a}	11.29±1.01^{a}	11.19±0.77^{a}
Empty gizzard, g	57.29±5.08^{a}	62.36±7.40^{a}	59.63±2.05^{a}	56.82±4.26^{a}	60.52±2.09^{a}
Abdominal fat, g	54.30±7.33^{a}	32.22±6.95^{b}	30.27±4.96^{b}	17.83±5.81^{c}	21.94±1.86^{c}
Abdominal fat, %	2.39±0.35^{a}	1.32±0.31^{b}	1.24±0.21^{b}	0.80±0.26^{c}	0.95±0.07^{c}
Carcass weight*,g	1591.67±30.0^{b}	1749.67±46.1^{a}	1768.00±74.1^{a}	1634.00±15.1^{ab}	1681.00±22.8^{ab}
Carcass %	69.83±0.12^{c}	71.60±1.10^{b}	72.47±2.62^{ab}	72.83±0.48^{a}	73.17±0.69^{a}
Bursa weight, g	4.27±0.26^{a}	2.45±0.25^{c}	2.76±0.06^{bc}	3.32±0.24^{b}	2.73±0.23^{bc}
Bursa %	0.187±0.01^{a}	0.101±0.01^{c}	0.113±0.003^{bc}	0.148±0.011^{b}	0.119±0.01^{bc}
Thymus weight, g	2.83±0.06^{a}	2.25±0.03^{c}	2.47±0.04^{b}	2.46±0.06^{b}	1.88±0.11^{d}
Thymus %	0.124±0.001^{a}	0.092±0.001^{c}	0.101±0.001^{bc}	0.110±0.002^{b}	0.082±0.006^{d}
Spleen weight, g	2.38±0.19^{d}	3.30±0.14^{bc}	3.67±0.24^{b}	2.96±0.05^{c}	4.50±0.11^{a}
Spleen %	0.105±0.01^{c}	0.135±0.01^{b}	0.151±0.01^{b}	0.132±0.002^{b}	0.196±0.005^{a}

a– d Means with different superscripts within each row are significantly different ($P \leq 0.05$).

*Carcass weight = Eviscerated weight

Table (5): Effect of different levels of zinc on plasma total protein, albumin, globulin, A\G ratio creatinine,total lipids,triglycerides and cholesterol of male broiler chicks (mean±SE).

Items	Zn level mg/kg diet				
	0	50	100	150	200
Total protein (g/dl)	4.66±0.18[c]	4.91±0.37[bc]	6.05±0.18[a]	5.26±0.20[abc]	5.57±0.18[ab]
Albumin (g/dl)	2.45±0.18[c]	2.61±0.20[b]	2.85±0.22[a]	2.61±0.21[b]	2.83±0.24[a]
Globulin (g/dl)	2.21±0.17[b]	2.30±0.41[b]	3.20±0.16[a]	2.65±0.16[ab]	2.74±0.16[ab]
A\G ratio	1.12±0.08[a]	1.24±0.29[a]	0.89±0.30[a]	0.99±0.25[a]	1.04±0.05[a]
Creatinine (mg\dl)	1.08±0.02[c]	1.16±0.03[b]	1.25±0.03[a]	1.28±0.02[a]	1.31±0.12[a]
Total lipids (mg/dl)	4.51±0.18[d]	5.71±0.04[c]	6.37±0.04[b]	6.07±0.06[b]	6.78±0.05[a]
Triglycerides (mg/dl)	77.00±2.51[b]	88.66±2.33[a]	90.67±1.86[a]	91.33±2.03[a]	89.33±2.33[a]
Cholesterol (mg/dl)	170.00±2.88[a]	169.67±1.20[a]	173.67±2.96[a]	168.67±2.40[a]	173.33±2.40[a]

a-d Means within the same row having different superscripts are significantly different ($P \leq 0.05$).

Table (6) Effect of different levels of zinc on some hematological parameters of male broiler chicks (mean ± SE).

Items	Zn level mg/kg diet				
	0	50	100	150	200
RBCs ($x10^6/mm^3$)	1.74±0.07[a]	1.80±0.04[a]	1.69±0.02[a]	1.82±0.05[a]	1.77±0.03[a]
WBCs ($x10^3/mm^3$)	57.37±1.94[c]	62.60±1.39[b]	67.18±2.08[a]	70.19±1.22[a]	69.97±1.90[a]
Hb g/dl	9.47±0.17[a]	9.53±0.16[a]	9.15±0.09[a]	9.46±0.04[a]	9.63±0.23[a]
PCV %	31.49±0.89[a]	30.59±0.80[a]	30.55±1.49[a]	30.97±0.88[a]	30.97±1.39[a]
MCV	129.60±1.56[a]	127.30±1.29[a]	127.97±1.42[a]	127.87±2.28[a]	126.96±2.29[a]

a-c Means within the same row having different superscripts are significantly different ($P \leq 0.05$).
PCV = packed cell volume
MCV = mean corpuscular volume

Table (7): Input-output analysis and economical efficiency of different dietary treatments.

Items	Zn level mg/kg diet				
	0	50	100	150	200
Average feed consumed (kg)	4.686	4.813	4.773	4.406	4.482
Price/kg feed consumed (PT)[1]	88.082	88.487	88.744	88.994	89.434
Total feed cost (PT)	412.752	425.888	423.575	392.108	400.843
Average live Weight (kg)	2.229	2.410	2.401	2.211	2.171
Price/kg live Weight (PT)[2]	600.00	600.00	600.00	600.00	600.00
Total revenue (PT)	1337.40	1446.00	1440.60	1326.60	1302.60
Net revenue (PT)	924.648	1020.112	1017.025	934.492	901.757
Economic efficiency (EE)[3]	2.240	2.395	2.401	2.383	2.250
Relative economic efficiency[4]	100.00	106.92	107.19	99.50	100.45

Price 1kg Zn SO_4 = 16 LE.
1 Total price of feed consumed at starting, growing and finishing periods/feed consumed +price Zn SO_4.
2 According to the local market price at the experimental time (2002).
3 Net revenue per unit food cost.
4 Assuming the E.E. of control diet equals 100.

help in determination of blood and hematological parameters.

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تأثير إضافة الزنك للعليقة على النمو وصفات الذبيحة وبعض قياسات الدم لكتاكيت التسمين

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أجريت هذه التجربة لدراسة تأثير إضافة ٤ مستويات من الزنك (كبريتات الزنك) في العلائق علي النمو و صفات الذبيحة وبعض قياسات الدم والكفاءة الإقتصادية لكتاكيت التسمين. تم أجراء التجربة علي ٢٠٠ كتكوت تسمين أربو ايكرز (ذكور) عمر يوم قسمت عشوائيا إلي ٥ مجاميع تجريبية كانت المجموعة الأولي منها كنترول وباقي المجاميع غذيت علي العليقة الكنترول مضافا إليها أحد مستويات الزنك التالية ٥٠و١٠٠و١٥٠ و٢٠٠ ملجم زنك/كجم عليقه علي التوالي.واستمرت التجربة لمدة سبع أسابيع.

١ - كان هناك تحسن معنوي في وزن الجسم عند نهاية التجربة والزيادة المكتسبة الكلية في وزن الجسم عند عمر ٧ أسابيع للكتاكيت المغذاة علي علائق مضاف إليها الزنك بمستويات ٥٠ و ١٠٠ ملجم / كجم عليقه بالمقارنة بالمجموعة الكنترول. بينما كان هناك انخفاض معنوي في الزيادة في وزن الجسم فى نهاية التجربة للكتاكيت المغذاة علي علائق مضاف إليها الزنك بمستويات ١٥٠ و ٢٠٠ ملجم/كجم عليقه عند المقارنة بالمجموعة الكنترول. وكان هناك انخفاض معنوي في كمية الغذاء المستهلك طول فترة التجربة للكتاكيت المغذاة علي علائق مضاف إليها الزنك بمستويات ١٥٠ و ٢٠٠ ملجم/كجم عليقه بالمقارنة بالمجموعة الكنترول والمجاميع التجريبية الأخرى.

٢ - كما حدث تحسن معنوي في كفاءة تحويل الغذاء طول فترة التجربة للكتاكيت المغذاة علي علائق مضاف إليها الزنك بمستويات ٥٠ و ١٠٠ او ١٥٠ ملجم زنك / كجم عليقه بالمقارنة بالمجموعة الكنترول.

٣– لم يكن هناك اختلاف معنوى في وزن الكبد و القلب و القانصة فارغة بين المجاميع التجريبية و الكنترول.بينما أظهرت النتائج انخفاض معنوي في وزن دهن البطن و النسبة المئوية لدهن البطن للكتاكيت المغذاة علي علائق مضاف إليها الزنك بمستويات ٥٠ و ١٠٠ او ١٥٠ او ٢٠٠ ملجم زنك/كجم عليقه عند المقارنة بالمجموعة الكنترول. كما أدى إضافة الزنك للعلائق إلى زيادة معنوية في وزن الذبيحة للكتاكيت المغذاة علي علائق مضاف إليها الزنك بمستويات ٥٠ و ١٠٠ ملجم زنك/كجم عليقه عند المقارنة بالمجموعة الكنترول. بينما كانت هناك زيادة معنوية في النسبة المئوية لوزن الذبيحة في جميع المجاميع التجريبية المضاف إليها الزنك بالمقارنة بالكنترول.كما أدى إضافة الزنك للعلائق إلى انخفاض وزن محفظة فابريشيوس و الغدة التيموسية وزيادة وزن الطحال في جميع المجاميع التجريبية بالمقارنة بالكنترول.

٤ - كانت هناك زيادة معنوية في بروتين البلازما الكلي للكتاكيت المغذاة على علائق مضاف إليها الزنك بمستويات ١٠٠ او ٢٠٠ ملجم زنك /كجم عليقه عند المقارنة بالكنترول.كما كانت هناك زيادة معنوية في ألبيومين البلازما فى جميع المجاميع التجريبية المضاف إليها الزنك بالمقارنة بالكنترول. كما أوضحت النتائج زيادة معنوية فى جلوبيولين البلازما للكتاكيت المغذاة على عليقة مضاف إليها الزنك بمستوي ١٠٠ املجم زنك/كجم عليقه عند المقارنة بالكنترول.

٥ - كما كانت هناك زيادة معنوية في الدهن الكلي للبلازما و الكرياتينين و الدهون الثلاثية فى جميع المجاميع التجريبية المضاف إليها الزنك بالمقارنة بالكنترول. بينما لم يكن هناك زيادة معنوية في معدل الألبيومين على الجلوبيولين و الكولسترول الكلى بين المجاميع التجريبية و الكنترول.

٦ - لم يكن هناك اختلافات معنوية فى عدد كرات الدم الحمراء و الهيموجلوبين ومتوسط حجم الخلايا وحجم الخلايا المترسبة بين المجاميع التجريبية و الكنترول بينما كان هناك زيادة معنوية فى عدد كرات الدم البيضاء للكتاكيت المغذاة علي علائق مضاف إليها الزنك عند المقارنة بالمجموعة الكنترول.

٧ - كما أوضحت نتائج الدراسة الإقتصادية أن إضافة الزنك إلى العليقة الكنترول بمستويات ٥٠ و ١٠٠ ملجم / كجم عليقه أدى إلى تحسين الكفاءة الإقتصادية للعلائق بالمقارنة بالكنترول.

وتوضح هذه الدراسة أن إضافة الزنك إلى علائق كتاكيت التسمين بمستويات ٥٠ و ١٠٠ ملجم زنك/ كجم عليقه كان الأكثر كفاءة في تحسين أداء الكتاكيت و الكفاءة الإقتصادية للعلائق وزيادة وزن الذبيحة و النسبة المئوية للذبيحة وتقليل نسبة الدهن في البطن وينصح بإضافة المستوى الأقل في العلائق (٥٠ ملجم / كجم عليقة).