Plant Archives Vol. 20, Supplement 2, 2020 pp. 297-300 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

EFFECT OF ADDING DIFFERENT LEVELS OF ZINC ON THE PHYSICAL AND QUALITY CARCASS CHARACTERISTICS OF BROILER CHICKENS

Saja S. Al-Bayati* and R.S. Al-Mahdawi

Department of Animal Production, College of Agricultural Engineering Science, University of Baghdad, Iraq

Abstract

An experiment was conducted at the field of poultry birds-Animal Production Department, College of Agricultural Engineering Sciences, University of Baghdad during the period from 9 October 2017 to 19 November 2017 to study the effect of adding different levels of organic zinc to the diet on the physical and quality characteristics of broiler chickens carcass at the age of 42 day. 300 broiler chickens 308-Ross strain were used at a weight rate of 39.64 g, and they were divided into five treatments. Each treatment divided into 3 replicates (20 chickens/repeated) randomly. The chickens were fed to the starter diet from 1 to 21 days with a protein ratio 23% and the metabolizable energy is 3003 Kilocalories/Kg, while the final diet from 22 to 42 days with a protein ratio of 20% and the metabolizable energy is 3201 Kilocalories/Kg. The organic zinc was added to the diet from the age of one day until the end of the experiment at levels of 20, 40, 60 and 80 mg/Kg feed for treatments T2, T3, T4 and T5, respectively, while the control treatment (T1) was left without addition.

The results indicated significant superiority ($p < 0.05$) for the carcass weight for all zinc addition treatments compared with control treatment (T1). The T2 treatment recorded a significant superiority ($p < 0.05$) of the thigh weight, while the T4 treatment recorded a significant superiority of the neck and wing weight ($p < 0.05$). Also, zinc addition treatments significant superiority in the length, weight and thickness of the drumstick compared with T1 treatment ($p < 0.05$), and there was significant superiority ($p < 0.05$) for all zinc addition treatments in the length, weight and thickness of the thigh compared with control treatment (T1).

***Keywords* :** Zinc, broiler chicken, metabolizable energy.

Introduction

The use of micronutrients in poultry feeding is very important, as these elements have a clear effect on the growth rate and metabolic rate in poultry, which will be reflected in its productive performance, whether it is meat or eggs, as well as its importance in biological, reproductive and immune processes (Yatoo *et al.*, 2013). These elements play an effective role in improving the growth of poultry as they are enzymic catalysts and raw materials for building their systems in a number of body cells (Swiatkiewicz *et al.*, 2014).

The sources of minerals in poultry diets are either through the food material included in their composition or from traditional inorganic sources such as oxides, sulfates or carbonates, which are relatively low in their vital availability to poultry needs, while the requirements of modern breeds of these elements is very high, which necessitates the need to find sources for these minerals making them more ready for poultry (Mohanna and Nys, 1998).

Zinc (Zn) is one of the trace essential minerals for domestic birds. It is one of the important mineral elements in the body of the organism, as it contributes to building more than 300 enzymes (Plum *et al.*, 2010) and it plays an important role in the formation of erythrocytes (Aksu *et al.*, 2010). Also, Zinc has a role in increasing weight and improving the nutritional conversion factor for broiler meat, as well as increasing egg production and thickening of the shell (Sahin *et al.*, 2002, Rouhalamini *et al.*, 2014). Al-Bayati and Al-Mahdawi (2018) reported that the adding of organic zinc to the broiler chickens diet led to improving productive characters. From other hand, zinc deficiency results in a number of physiological and pathological changes, including reduced growth, bone irregularity, reduced feathers appearance and reduced immunity against a number of diseases (Underwood and Suttle, 1999). The aim of this research was to study the effect of adding different levels of organic zinc to the diet on the physical and quality characteristics of the broiler chickens carcass at the age of 42 day.

Materials and Methods

An experiment was conducted at the field of poultry birds-Animal Production Department, College of Agricultural Engineering Sciences, University of Baghdad during the period from 9 October 2017 to 19 November 2017 to study the effect of adding different levels of organic zinc to the diet on the physical and quality characteristics of broiler chickens carcass at the age of 42 day. 300 broiler chickens 308-Ross strain were used at a weight rate of 39.64 g, and they were divided into five treatments. Each treatment was divided into 3 replicates (20 chickens / repeated) randomly. The chickens were fed to the starter diet from 1 to 21 days. While the final diet from 22 to 42 days. The organic zinc was added to the diet from the age of one day until the end of the experiment at levels of 20, 40, 60 and 80 mg/Kg feed for treatments T2, T3, T4 and T5, respectively, while the control treatment (T1) was left without addition. The commercial compound Availa®-Zn 120 (12% Zinc amino acid complex) produced by the American company ZINPRO was used to supply the organic zinc. Table 1 shows the chemical composition of the diet used in the experiment, and Table 2 shows the total content of zinc in all experimental diets as it was calculated according to NRC (1994).

Studied characteristics

1. Dressing percentage (%)

At the end of the experiment (at the age of 42 days), the birds fasted 4 hr before the slaughter process, 3 birds randomly were slaughtered each replication, after which the feathers and internal guts ((susceptible and inedible) were removed and the edible internal organs were isolated to calculate the dressing percentage according to Al-Fayyadh and Naji (1989):

$$\text{Dressing ratio}\ (\%) = \frac{\text{Carcass weight}}{\text{Live body weight}} \times 100$$

2. Relative weight of carcass cuts (%)

The carcasses were weighed and cut into the main cuts, which are the breast, thigh and drumstick, and the secondary cuts, which are the back, neck and the wings, and each piece was weighed separately and the relative weight of the cuts was calculated according to Al-Fayyadh *et al.* (2011):

$$\text{Relative weight of carcass cuts}\ (\%) = \frac{\text{Weight of the cut carcass}}{\text{Carcass weight}} \times 100$$

3. Carcass bone measurements

The length, thickness and weight of the thigh and drumstick bones were calculated according to Al-Fayyadh *et al.*, (2011).

Table 1 : The feed components of the standard diet included in the composition of the starter and final diets of the broiler chickens and the chemical composition calculated

feed components	Starter diet (%) (1-21 days)	Final diet (22-42 days)
Maize	30.6	40.5
Soybean meal (Crude protein 48%)	31.7	24.9
Wheat	28	22.7
Animal protein concentrated*	5	5
Sunflower oil	2.5	4.7
NaCl	0.3	0.3
Limestone	1	1
Di calcium phosphate	0.7	0.7
Mix vitamins and minerals**	0.2	0.2
Total	100	100
Chemical composition calculated		
Metabolizable energy (Kilocalorie / Kg)	3003	3201
Crude protein (%)	23	20
Calcium (%)	0.88	0.87
Phosphor (%)	0.52	0.51
Lysine (%)	1.29	1.1
Methionine (%)	0.49	0.458
Methionine + Cysteine (%)	0.83	0.75

*Protein Concentrated Special 5-Brocon w each 1 Kg contains: Crude protein (40%), Fat (5%), Crude fiber (2.2%), Ash (24.52%), Lysine (3.85%), Methionine (3.7%), Methionine + Cysteine (4.12%), Tryptophan (0.43%), Arginine (2.57%), Ca (3.53%), P (5.35%), Na (2.40%), Metabolizable Energy (2107 Kilocalorie / Kg), Vit. A (200000 I.U.), Vit. D_3 (60000 I.U.), Vit. E (600 I.U.), Vit. K_3 (50 mg), Vit. B_1 (60 mg), Vit. B_2 (140 mg), Vit. B_6 (80 mg), Vit. B_{12} (700 µg), Vit. B_3 (800 mg), Folic acid (20 mg), Fe (1000 mg), Cu (200 mg), Mn (1600 mg), Zn (1200 mg), I (20 mg), Se (5 mg).
**Mix vitamins and minerals each 1 Kg contains: Vit. A (500 I.U.), Vit. D_3 (600 I.U.), Vit. E (10 mg), Vit. K_3 (2 mg), Vit. B_1 (2 mg), Vit. B_2 (2 mg), Vit. B_6 (2 mg), Vit. B_{12} (5 µg), Vit. C (10 mg) Vit. B_3 (15 mg), Folic acid (500 µg), Zn (10 mg).

Table 2 : Total Zn percentage in the diets after adding zinc

Treatment	Zinc (mg Zn / Kg fodder)	
	Initial diet	Final diet
T1	112.5	**109.0**
T2	**132.5**	**129.0**
T3	**152.5**	**149.0**
T4	**172.5**	**169.0**
T5	**192.5**	**189.0**

The data were statistically analyzed by using the complete randomized design and SAS (2001) program and the significant differences between means were compared by using the Duncan Polynomial test (Duncan, 1955).

Results and Discussion

Carcass weight and dressing percentage

The results at the table 3 indicate that there is significant superiority ($p < 0.05$) on the carcass weight for all zinc addition treatments T2, T3 T4 and T5 which recorded 1925.00, 1972.31, 2048.22 and 2033.28 g, respectively compared with the control treatment (T1) which recorded lowest mean 1728.72 g. The reason of the significant superiority of the carcasses weight when addition of organic zinc compared with control treatment could be attributed to the utilization of the bird's body from the zinc that enters in the composition of important enzymes in the body and its role as a catalyst and raw material for build a number of body cells, which leads to increased use the bird of the nutrients during the digestion and absorption processes and converted into an overweight and then an increase the weight of the carcass (Swiatkiewicz *et al*., 2014). Also, the results at the table 3 show that there no significant difference between treatments in the dressing percentage.

Table 3 : Effect of adding different levels of organic zinc to the broiler diet on the carcass weight and the dressing percentage (mean ± standard error) of the broiler chicken carcasses.

Treatment	carcass weight (g)		dressing percentage (%)	
T1	1728.72 ± 44.14	b	76.75 ± 0.75	a
T2	1925.00 ± 52.77	a	78.00 ± 1.63	a
T3	1972.31 ± 59.96	a	75.74 ± 1.36	a
T4	2048.22 ± 44.90	a	77.28 ± 0.92	a
T5	2033.28 ± 49.02	a	78.63 ± 1.74	a
Probability level	0.05		N.S	

Relative weight of the main carcass cuts

The results at the table 4 show that there no significant difference between treatments in the breast relative weight, while there is significant difference ($p < 0.05$) between zinc addition treatments on the thigh relative weight, the T2 treatment gave highest percentage 26.15% compared with other treatments especially T4 which gave lowest percentage 23.33% without significant difference on the T1, T3 and T5 which gave 24.68, 24.92 and 24.50%, respectively. The results at the table 5 indicate that there no significant difference between treatments in the back relative weight, whereas there is significant difference ($p < 0.05$) between zinc addition treatments on the wing and neck relative weight, the T4 treatment gave highest percentages 10.30% and 5.12% compared with other treatments especially T3 which gave lowest percentages 9.33% and 4.70% for two traits, respectively. The improvement in some measures of carcasses when adding organic zinc could be due to the real increase in live body weight and carcass weight, and then the increase in the body's growth and its fleshy muscles, which contributes mainly to containing these carcasses on a high percentage of main cuts such as the thigh and breast to focus the fleshy muscles in them more of the other parts of the carcass (Al-Baghdadi, 1995).

Table 4 : Effect of different levels adding of organic zinc to the broiler diet on the relative weight of the main carcass cuts

Treatment	Relative weight of the main carcass cuts (%)			
	Breast		thigh	
T1	35.93 ± 0.97	a	24.68 ± 0.87	ab
T2	34.75 ± 0.66	a	26.15 ± 0.74	a
T3	35.92 ± 0.55	a	24.92 ± 0.45	b
T4	36.11 ± 0.42	a	23.33 ± 0.50	b
T5	36.40 ± 0.37	a	24.50 ± 0.50	ab
Probability level	N.S		0.05	

Table 5 : Effect of different levels adding of organic zinc to the broiler diet on the relative weight of the secondary carcass cuts

Treatment	Relative weight of the secondary carcass cuts (%)					
	Back		Wing		Neck	
T1	20.05 ± 0.49	a	10.07 ± 0.17	ab	4.86 ± 0.10	ab
T2	19.93 ± 0.52	a	9.79 ± 0.20	abc	4.89 ± 0.14	ab
T3	20.63 ± 0.42	a	9.33 ± 0.18	c	4.70 ± 0.16	b
T4	20.85 ± 0.72	a	10.30 ± 0.15	a	5.12 ± 0.05	a
T5	20.03 ± 0.60	a	9.76 ±0.17	bc	5.00 ± 0.09	ab
Probability level	N.S		0.05		0.05	

Carcass bone measurements

The results at the table 6 show that there significant difference ($p < 0.05$) between treatments in the drumstick bone measurements except the meat weight of the drumstick bone, the T3 treatment had highest means of the length 12.61 cm, thickness 10.73 mm and weight 24.78 g of the drumstick bone without significant difference on the T2, T4 and T5 treatments, while the control treatment (T1) had lowest means 11.49 cm, 9.27 mm and 20.47 g, respectively. Also, the results at the table 6 indicate that there significant difference ($p < 0.05$) between treatments in the thigh bone measurements except the meat weight of the thigh bone, the T3 treatment recorded highest means of the length 9.19 cm, thickness 10.55 mm of the thigh bone without significant difference on the T2, T4 and T5 treatments, while the T4 treatment recorded highest mean of the thigh bone weight 18.77 g without significant difference on the T2, T3 and T5 treatments, whereas the control treatment (T1) recorded lowest means 8.24 cm, 9.01 mm and 14.87 g, respectively. The reason of the superiority of the organic zinc addition treatments could be attributed to the role of zinc in maintaining tissue integrity and involved in the synthesis of proteins, such as creatine and collagen, also it's an important element in bone building which were positively reflected on the carcass bone measurements such as length, thickness bone (Bao *et al.*, 2007; Rossi *et al.*, 2007). From other hand, the increasing of the length bone means increasing the length of the skeletal muscles located on it, especially in the main parts of the carcass and then increasing of the body's weight (Al-Hajo, 2005; Al-Fayyadh *et al.*, 2011). These results are in agreement with Tronina *et al.* (2007) and Al-Bayati and Al-Mahdawi (2018) who reported that the adding of zinc to diets lead to increase carcass characteristics of broiler chickens. We conclude from the current study that the addition of organic zinc to broiler diets can be improving the physical and quality carcass characteristics of broiler chickens.

Table 6 : Effect of different levels adding of organic zinc to the broiler diet on the carcass bone measurements

Treatment	The drumstick bone measurements							
	Length (cm)		Thickness (mm)		Weight (g)		Meat Weight (g)	
T1	11.49 ± 0.10	b	9.27 ± 0.09	b	20.47 ± 0.33	b	86.02 ± 3.62	a
T2	12.22 ± 0.14	a	10.38 ± 0.06	a	24.06 ± 0.22	a	101.51 ± 7.38	a
T3	12.61 ± 0.08	a	10.73 ± 0.10	a	24.78 ± 0.40	a	77.97 ± 15.17	a
T4	12.40 ± 0.21	a	10.49 ± 0.16	a	24.15 ± 0.15	a	97.52 ± 6.73	a
T5	12.57 ± 0.09	a	10.50 ± 0.15	a	24.67 ± 0.15	a	99.16 ± 4.86	a
Probability level	0.05		0.05		0.05		N.S	
Treatment	The thigh bone measurements							
	Length (cm)		Thickness (mm)		Weight (g)		Meat Weight (g)	
T1	8.24 ± 0.03	b	9.01 ± 0.12	b	14.87 ± 0.68	b	99.96 ± 5.77	a
T2	8.81 ± 0.15	a	10.10 ± 0.11	a	18.02 ± 0.38	a	111.48 ± 7.01	a
T3	9.19 ± 0.14	a	10.55 ± 0.13	a	18.50 ± 0.22	a	108.48 ± 3.62	a
T4	8.84 ± 0.18	a	10.10 ± 0.36	a	18.77 ± 0.59	a	111.56 ± 4.42	a
T5	9.02 ± 0.18	a	10.14 ± 0.29	a	18.17 ± 0.37	a	109.58 ± 5.41	a
Probability level	0.05		0.05		0.05		N.S	

References

Al-Baghdadi, M.F.; Hassan, A.A. and Shawkat, T.F. (1995). Effect of genetic line and density on qualitative traits of cuts of male carcass on two line of broiler. J. Al-Basrah of Agric. Sci., 8(2): 11-13.

Al-Bayati, S.S. and Al-Mahdawi, R.S. (2018). Effect of adding different levels of organic zinc on the production of broiler chickens. Plant Archives, 18(2): 2145-2150.

Al-Fayyadh, H.A. and Naji, S.A. (1989). Poultry Products Technology. 1st Edn., Higher Education Press Directorate, Baghdad, Iraq.

Al-Fayyadh, H.A.; Naji, S.A. and Abed, N.N. (2011). Poultry Products Technology. 2nd Edn., Part 2, Coll. of Agic., Univ. of Baghdad, Ministry of Higher Education and Scientific Res. Iraq.

Al-Hajo, N.N.A. (2005). Effect of Age on Productive Performance of Specific Quality and Sincere Age and Study The Economic Benefits of Project. Ph.D. Dissertation, Coll. of Agric., Univ. of Baghdad.

Aksu, D.S.; Aksu, T. and Ozsoy, B. (2010). The effects of lower supplementation levels of organically complexed minerals (zinc, copper and manganese) versus inorganic forms on hematological and biochemical parameters in broilers. Kafkas Univ. Vet. Fak. Derg. 16: 553-559.

Bao, Y.M.; Choct, M.; Iji, P.A. and Bruerton, K. (2007). Effect of organically complexed copper, iron, manganese, and zinc on broiler performance, mineral excretion, and accumulation in tissues. J. Appl. Poult. Res., 16: 448-455.

Duncan, D.B. (1995). Multiple range and multiple F-tests. Biometrics. 11: 1-42.

Mohanna, C. and Nys, Y. (1998). Influence of age, sex and cross on body concentrations of trace elements (zinc, iron, copper and manganese) in chickens. British Poultry Sci., 39(4): 536-543.

NRC. National Research Council. 1994. Nutrient requirement of poultry. 9th revisited National academy press, Washington D. C., U.S.A.

Plum, L.; Rink, L. and Hajo, H. (2010). The Essential Toxin: Impact of zinc on Human Health. Int J. Environ. Res. Public Health. 7(4):

Rossi, P.; Rutz, F.; Anti, M.A.; Rech, J.L. and Zauk, N.H.F. (2007). Influence of graded levels of organic zinc on growth performance and carcass traits of broilers. J. Appl. Poult. Res. 16(2): 219-225.

Rouhalamini, S.M.; Salarmoini, M. and Asadikaram, Gh. (2014). Effect of zinc sulfate and organic chromium supplementation on the performance, meat quality and immune response of Japanese quails under heat stress conditions. Poult. Sci. J. Guasnr. 2(2): 165-181.

Sahin, N.; Onderci, M. and Sahin, K. (2002). Effects of dietary chromium and zinc on egg production egg quality, and some blood metabolites of laying hens reared under low ambient temperature. Biol. Trace Elem. Res., 85: 47-58.

SAS (2001). SAS User's Guide : Statistics Version 6th edn., SAS Institute Inc., Cary, NC.

Swiatkiewicz, S.; Arczewska-Wlosek, A. and Jozefiak, D. (2014). The efficacy of organic minerals in poultry nutrition review and implications of recent studies. Worlds Poult. Sci. J., 70: 475-486.

Tronina, W.; Kinal, S. and Lubojemska, B. (2007). Effect of various forms of zinc applied in concentrate mixtures for broiler chickens on its bioavailability as well as meat composition and quality. Polish J. Food and Nut. Sci., 57(4C): 577-581.

Underwood, E.J. and Suttle, N.F. (1999). The mineral nutrition of livestock. 3rd Edn. In E. Cabho; C. Courtemanche and B. N. Ames. 2003. Zinc Deficiency Induces Oxidative DNA Damage and Increases P_{53} Expression in Human Lung Fibroblasts. J. Nut., 133: 2543-2548.

Yatoo, M.I.; Saxena, A.; Deepa, P.M.; Habeab, B.P.; Devi, S.; Jatav, R.S. and Dimri, U. (2013). Role of Trace elements in animals: A review. Vet. World. 6(12): 963-967.