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Performance and Carcass Characteristics of Broiler Chicks Fed Diets Supplemented with Commercial Zinc-Methionine

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ABSTRACT: *This work was conducted to study the effect of three levels of commercial organic mineral of zinc-methionine as commercial product in starter and finisher diets of broiler chicks. One hundred and ninety two unsexed Hubbard broiler chicks at three week of age were divided into four treatments (48 birds each), each treatment contained 4 replicates of 12 birds.*

The experimental treatments were as follows:

Treatment 1: ***Chicks were fed the control diet.***
Treatment 2: ***Chicks were fed the control diet + 0.3 g Zn + Mth /Kg diet.***
Treatment 3: ***Chicks were fed the control diet + 0.4 g Zn + Mth /Kg diet.***
Treatment 4: ***Chicks were fed the control diet + 0.5 g Zn + Mth /Kg diet.***

Chicks fed the diet supplemented with com. Zn Meth diet at the level of 0.5g Zn Meth./Kg diet had the highest value of live body weight (LBW) at 49 days of age (2473.2 g). Chicks fed the diet supplemented with 0.5 g Zn Meth./Kg diet had the heaviest live body weight gain (LBWG) during the period from 21 to 49 days of age (1777.9 g). Chicks fed the diet supplemented with 0.3 g Zn Meth./Kg diet had the lowest feed intake (FI) during the period from 21 to 49 days of age (3531.5 g). Chicks fed the diet supplemented with 0.3 g Zn Meth./Kg diet had the best feed conversion (FC), crude protein conversion (CPC) and caloric conversion (CCR) during the period from 36 to 42 days of age (2.14, 0.384 and 6.65 g, respectively). Chicks fed the diet supplemented with 0.5 Zn Meth./Kg diet had the highest values of GR during the period 21-49 days (0.868). Chicks fed the diet supplemented with 0.3 g Zn Meth./Kg diet had the highest value of performance index (PI) during the period from 36-42 days (115.37) and chicks fed the diet supplemented with 0.5 g Zn Meth./Kg diet had the highest value of PI during the periods 21-28 and 43-49 days (49.26 and 115.8, respectively). No significant differences were found among dietary treatments in chemical composition of broiler meat and carcass traits. Chicks fed the diet supplemented with 0.4 Zn Meth./Kg diet had the highest value of GPT. Economical efficiency (EEF) value at 42 days of age was improved in chicks diet supplemented with Zn Meth. as *compared with the control diet. Supplementing with 0.3 g Zn Meth /Kg diet gave the best economical and relative efficiency being 3.18 and 105.59 %, respectively followed by 0.4 g Zn Meth./Kg diet (3.17 and 105.04%, respectively) when compared with the control.*

In conclusion, supplementing broiler with commercial Zn-met. at level 0.3 or 0.4 g Zn-meth./ Kg diet significantly improved performance and economical efficiency.

Key words: Broiler, Zinc-Methionine, carcass characteristics.

INTRODUCTION

Trace element of poultry diets has traditionally been supplemented through the use of inorganic salts. However, the intrinsic and extrinsic factors are known to affect the bioavailability of dietary inorganic trace elements. Continuous efforts have been made over the past years to improve their utilization by poultry. It is well established that chalets of, Cu, Zn and Mn with amino acids and peptides can enhance the bioavailability of these trace elements, thereby leading to improved growth performance, reproduction and general health status when they are otherwise unavailable in sufficient amounts to meet bird needs. Nowadays, there are many such forms of metal complexes available in the market for use in poultry nutrition as “ organic trace minerals “.

Zinc has numerous biological roles including protein metabolism **(Forbes, 1984),** DNA synthesis **(Lieberman, *et. al.*, 1963),** cell division and multiplication **(Rubin, 1972 and Rubin and Koide, 1973),** the cell mediated immune response **(Fraker, *et al.*, 1977** and **Bertuzzi, *et al.*, 1998)** and performance **(Sadoval, *et al.*, 1999 and Collins and Moran, 1999),**carbohydrate metabolism, and basic functions in growth performance **(Mohanna, *et al.*, 1999).** Zinc is involved in boosting the immune system to disease outbreaks **(Luecke, *et al.*, 1978)**. Zinc is the only metal to be essential for at least one enzyme in all six enzyme classes as follows: Oxidoreductase (4 enzymes), transferase (3 enzymes), hydrolase (3 enzymes), lyase (one enzyme). isomerase (one enzyme) as well as ligase (one enzyme) **Kidd, *et al.* (1996).** Superoxide dismutase a crucial zinc metalloenzyme, protects cells and tissues from attach by superoxide produced by mononuclear phagocytes from molecular oxygen during the oxygen burst and so superoxide dismutase is vital for macrophage/hetrophill intregrity **(Cook- Mills and Fraker, 1993)**.

Broiler, Zinc-Methionine, Carcass Characteristics.

The Zinc-Methionine (Zn-Met) complex consists of $ZnSO_4$ complexed to DL-Methionine to yield a 1:1:1 ratio of Zn, Methionine and the sulfate ion. Zinc is coordinated between the amino and carboxyl groups of Methionine, and sulfate occupies the vacant bonds. Thus, Zn-Met is an organic complex of Zn; whereas ZnO and $ZnSO_4$ forms are inorganic sources **(Kidd, *et al.*, 1994)**. **Sanford (1972, 1974, 1975 and 1976)** reported improvement in broiler performance from Zn-Met fortification of broiler diets. However, **Potter, *et al.* (1974)** found no effect due to Zn-Met addition to broiler diets. Feeding Zn-Met to laying hens have shown improved performance **(Sanford, 1985; Sanford and Reddy, 1977 and Flinchum, 1990)** but it had no beneficial effect to laying hens **(Sanford, 1979 and 1984)**. Also, **Waibel, *et al.* (1974)** reported that Zn-Met in diets resulted in overall beneficial responses in turkey growth and egg production.

Ferket, *et al.* (1992) observed that turkey toms fed diets supplemented with Zn-Met had improved feed conversion. Moreover, **Kidd, *et al.* (1994)** reported that Zn-Met supplementation increased body weight by 6 % in youing turkey. This may be du to the fact that phytic acid in plant diets inhibits absorption of Zn **(O'Dell and Savage, 1960)**. Re-absorption of both endogenously secreted Zn and dietary Zn are impaired by presence of phytic acid. Furthermore, phytic acid lowers the absorption of Zn through formation of an insoluble complex in the lumen of intestine **(Oberleas, *et al.*, 1966)**. Organic Zinc as Zn-Met. may be more biologically available than inorganic form such as ZnO. **Abou EL-Wafa, *et al.* (2003)** reported that supplementing broiler with commercial organic mineral products of zinc-methionine (inorganic) significantly improved body weight, feed conversion and blood plasma of total protein, globulin compared with the control diet during 21-42 days of age or overall period. Dietary Zn-Met did not affect carcass characteristics (percentages of dressing, liver, heart, gizzard and abdominal fat). Also, they indicated that addition of zinc-methionine to control diet recorded the best economical efficiency compared with the other treatments.

The present experiment was conducted to study the influence of three levels of commercial organic mineral of zinc – methionine as commercial product on growth performance, carcass characteristics and some blood constituents.

MATERIALS AND METHODS

This work was carried out at El Takamoly Poultry Project, Fayoum, Egypt, to study the effect of three levels of commercial organic mineral of zinc-methionine as commercial product in starter and finisher diets of broiler chicks. Chemical analyses were performed in the laboratories of the Poultry Production Department, Faculty of Agriculture, Fayoum University, according to the procedures outlined by **A.O.A.C. (1990).**

One hundred and ninety two unsexed Hubbard broiler chicks at three week of age were divided into four treatments (48 bird each), each treatment contained 4 replicates of 12 birds.

The experimental treatments were as follows:

Treatment 1 : Chicks were fed the control diet.

Treatment 2 : Chicks were fed the control diet + 0.3 g Zn+Mth /Kg diet.

Treatment 3 : Chicks were fed the control diet + 0.4 g Zn+Mth /Kg diet.

Treatment 4 : Chicks were fed the control diet + 0.5 g Zn+Mth /Kg diet.

The experimental diets were supplemented with a minerals and vitamins mixture along with L-lysine and DL-methionine to cover the recommended requirements according to **CLFF, (2001)** and were formulated to be iso-nitrogenous and iso-caloric (Table 1). Chicks were individually weighed, wing-banded and randomly allotted to dietary treatments. Chicks were raised in electrically heated batteries with raised wire mesh floors and had free access to feed and water. Batteries were placed into a room provided with continuous light and fans for ventilation. The birds were reared under similar managerial conditions, and were given the experimental diets from the end of the three week until 28 days (starter diets) and from 29 to 49 days of age (finisher diets).

Birds were individually weighed to the nearest gram at weekly intervals during the experimental period. At the same time, feed consumption was recorded and feed conversion (g feed/g gain) and body weight gain were calculated. Crude protein conversion (CPC), caloric conversion ratio (CCR), specific gravity and performance index were also calculated **(Ragab, 2001)**.Growth rate (GR), was calculated using the following formula according to the equation of **Larner and Asundson (1932):**

$$GR = ((LBW_2 – LBW_1) / 0.5 (LBW_2 + LBW_1)) \mathbf{x} 100$$

Where: LBW_1 and LBW_2 are body weights at early and late ages studied.

Cumulative mortality % were calculated during the starting and finishing periods. At the end of the experiment (49 days), a slaughter test was performed using four chicks around the average LBW of each treatment. Birds were individually weighed to the nearest gram, and slaughtered by severing the carotid artery and jugular veins (islamic method). After four minutes of bleeding, each bird was dipped in a water bath for two minutes and feathers were removed by hand. After the removal of head, carcasses were manually eviscerated to determine some carcass traits, dressing% (eviscerated carcass without head, neck and legs) and total giblets % (gizzard, liver, spleen and heart). The eviscerated weight included the front part with wing and hind part. The abdominal fat was removed from the parts around the viscera and gizzard, and was weighed to the nearest gram. Chemical analyses of representative samples of the experimental diets and carcass meat (without skin) were carried out to determine percentages of DM, CP (N x 6.25), EE, CF and ash contents according to the methods of **A.O.A.C (1990).** Nitrogen free extract (NFE) was calculated by difference.

Individual blood samples were collected during exsanguinations, immediately centrifuged at 3500 rpm for 15 min. Plasma were harvest after centrifugation of the clotted blood, stored at–20Ċ in the deep freezer until the time of chemical determinations. The biochemical characteristics of blood were determined colorimetrically, using commercial Kits. Plasma total protein was measured by colorimetric method as described by **Weichselbaum (1946)**. Albumin concentration was determined according to the method of **Drupt (1977).** Globulin concentration was calculated as the difference between total protein and albumin. Cholesterol concentration was measured by the method of **Allain (1974)**. Triglycerides concentration was determined by the method of **Werner *et al.*, 1981.** AST and ALT were measured according to **Reitman and Frankel (1957)**. Calcium concentration was determined by the method of **Baver (1981).** Glucose concentration was measured by the method of **Trinder (1964).**

To determine the economical efficiency for meat production, the amount of feed consumed during the entire experimental period was obtained and multiplied by the price of one Kg of each experimental diet which was estimated based upon local current prices at the experimental time. Analysis of variance was conducted according to **Steel and Torrie (1980).** Significant differences among treatment means were determined using Duncan's multiple range test **(Duncan, 1955).**

RESULTS AND DISCUSSION

Productive performance:

Live body weight (LBW):

Data presented in Table 2 showed that com. Zn Meth diet significantly affected LBW ($P \leq 0.05$ or $P \leq 0.01$) at 28, 35, 42 and 49 days of age. Chicks fed the diet supplemented with com. Zn Meth diet at the level of 0.5g Zn Meth./Kg diet had higher values of LBW at 28, 42 and 49 days of age (1043.4, 1954.1 and 2473.2 g, respectively), and at the level of 0.4 g Zn Meth./Kg diet at 35 days of age (1521.5g). These results agree with the finding of **Abou EL-Wafa *et al.* (2003)** who reported that supplementing broiler with commercial organic mineral products of Zinc-methionine (inorganic) to control diet significantly improved body weight (1698 vs 1510 gm), compared with the control diet during 21-42 days of age or overall period.

Live body weight gain (LBWG) :

Data presented in Table 2 showed that com.Zn Meth. significantly affected LBWG ($P \leq 0.01$) during the periods 21 to 28, 36 to 42 and 21 to 49 days. Chicks fed the diet supplemented with 0.5 g Zn Meth./Kg diet had the heaviest LBWG during the periods from 21 to 28, 36 to 42 and 21 to 49 days of age (347.9, 460.3, and 1777.9 g, respectively) as compared with the control and the other supplements at the same periods. This is in accordance with the previous data on LBW. In general, adding com.Zn Meth. to the control diet improved body weight gain. These results agree with the finding of **Sanford (1972, 1974, 1975 and 1976)** who reported improvement in broiler performance from Zn-Met fortification of broiler diets. Also, **Kidd, *et al.* (1994)** reported that Zn-Met supplementation increased body weight by 6 %. This may be interpreted based on phytic acid in plant diets which inhibits absorption of Zn **(O'Dell and Savage, 1960)**. Re-absorption of both endogenously secreted Zn and dietary Zn are impaired by presence of phytic acid. However, **Potter, *et al.* (1974)** found no effect due to Zn-Met addition to broiler diets .

Feed intake (FI):

Data presented in Table 2 showed that Zn Meth significantly affected FI (P≤0.01) during all periods studied. Chicks fed the diet supplemented with 0.3 g Zn Meth./Kg diet had the lowest FI during the periods from 21 to 28, 29 to 35, 36 to 42 and 21 to 49 days of age (694.2, 886.3, 742.1 and 3531.5 g, respectively). While chicks fed the diet supplemented with 0.4 g Zn Meth./Kg diet had the lowest FI during the period from 43 to 49 days of age (1040.4g).

Feed conversion (FC):

Results presented in Table 3 indicated that com.Zn Meth. insignificantly affected FC during all periods studied except from 36 to 42 days of age. Chicks fed the diet supplemented with 0.3 g Zn Meth./Kg diet had the best FC during the periods from 36 to 42 days of age (1.91). These results agree with the finding of **Ferket, *et al.* (1992)** who observed that turkey toms fed diets supplemented with Zn-Met had improved feed conversion.Also, **Abou EL-Wafa, *et al.* (2003)** reported that supplementing broilers with commercial organic mineral products of Zinc-methionine significantly improved feed conversion (1.85 vs 2.1) compared with the control diet during 21-42 days of age or overall period.

Crude protein conversion(CPC) and caloric conversion ratio(CCR) :-

Data presented in Table 3 showed that Zn Meth. significantly affected CPC and CCR (P≤0.05) during the period from 36-42 days. Chicks fed the diet supplemented with 0.3 g Zn Meth./Kg diet had the best CPC and CCR during this period (0.384 and 6.65 g, respectively). While, Zn Meth. supplementation insignificantly affected CPC and CCR during the other periods studied.

Growth rate (GR): -

Data presented in Table 4 showed that Zn Meth. significantly affected GR (P≤0.05 and P≤0.01) during the periods from 21-28, 36-42 and 21-49 days. Chicks fed the diets supplemented with 0.4 or 0.5 g Zn Meth. had the highest values of GR during the period from 21-28 days (0.404) and chicks fed the diet supplemented with 0.5 Zn Meth./Kg diet had the highest values of GR during the periods 36-42 and 21-49 (0.266 and 0.868, respectively). While, GR values were insignificantly affected during the other periods studied.

Performance index (PI):-

Data presented in Table 4 showed that Zn Meth. significantly affected PI ($P \leq 0.05$ and $P \leq 0.01$) during the period from 21-28, 36-42 and 43-49 days. Chicks fed the diet supplemented with 0.3 g Zn Meth. had the highest values of PI during the period from 36-42 days (115.37) and chicks fed the diet supplemented with 0.5 Zn Meth./Kg diet had the highest values of PI during the periods 21-28 and 43-49 days (49.26 and 115.8, respectively). While, PI values were insignificantly affected during the other periods studied.

Chemical composition of broiler meat:

Results presented in Table 4 revealed no significant difference among dietary treatments in chemical composition of broiler meat.

Carcass characteristics :

As shown in Table 5, no significant difference are detected among dietary treatments in the carcass traits. It was clearly noted that chicks fed the control diets gave the best values for heart, carcass, dressing and specific gravity (0.498, 71.42, 75.87% and 1.032, respectively). While, chicks fed the diet supplemented with 0.3 Zn Meth./Kg diet had the highest values of liver, gizzard, spleen and total giblets%. Chicks fed diet supplemented with 0.5 Zn Meth./Kg diet had the highest value of abdominal fat flowed by chick fed the control diet. These results agree with the finding of **Abou EL-Wafa, *et al.* (2003)** who reported that supplementing broiler with commercial organic mineral products of Zinc-methionine did not affect carcass characteristics (percentages of dressing, liver, heart, gizzard and abdominal fat).

Plasma constituents: -

Data of plasma constituents analyses are summarized in Table 6. The results indicated insignificant effects of Zn Meth. supplementation on plasma constituents except that GPT ($P \leq 0.05$) had significant effect. Chicks fed the diet supplemented with 0.4 Zn Meth./Kg diet had the highest value of GPT.

Economical efficiency (EEF) :-

Results in Table 7 showed that EEF value at 7 weeks of age was improved in chicks fed the diet supplemented with Zn Meth./Kg diet as compared with the control diet. Supplementing Zn Meth/Kg diet at the level of 0.3g gave the best economical and relative efficiency being 3.18 and 105.59%, respectively then 0.4 g Zn Meth./Kg diet (3.17 and

105.04%, respectively) when compared with the control. These results agree with those of **Abou EL-Wafa, *et al.* (2003)** who indicated that addition of zinc-methionine to control diet recorded the best EEF compared with other treatments.

In conclusion, supplementing broiler with commercial Zn-meth. at level 0.3 or 0.4 g Zn-met./ Kg diet significantly improved performance and economical efficiency.

Table 1: Composition and analyses of the experimental diets.

Item, %	Starter diet	Finisher diet
Yellow corn, ground	61.0	66.3
Soybean meal (44 %CP)	35.5	26.0
Corn gluten meal (60%CP)	0.00	1.00
Vegetable oil	0.00	3.00
Di – calcium phosphate	1.70	1.70
Calcium carbonate	1.10	1.20
Sodium chloride	0.30	0.30
Vit. and Min. premix *	0.30	0.30
DL – Methionine	0.10	0.16
L-Lysine	0.00	0.04
Total	100	100
Calculated analysis (%)** :		
CP	20.86	17.81
EE	2.67	2.80
CF	2.72	2.49
Ca	0.93	0.95
Available P	0.43	0.42
Methionine	0.45	0.47
Methionine +Cystine	0.83	0.79
Lysine	1.21	0.98
ME, K cal/Kg	2838	3134

***Each 3.0 Kg of the Vit. and Min. premix contains :** Vit. A, 12000000 IU ; Vit. D_3 2500000 IU ; Vit. E, 10 g ; Vit. K, 2.5 g ; Vit. B1, 1.5 g ; Vit. B2, 5 g ; Vit. B6, 1.5 g; Vit. B12,10 mg ; Choline chloride, 1050 g ; Biotin, 50 mg ; Folic acid, 1 g ; Nicotinic acid , 30 g ; Ca pantothenate, 10 g ; Zn, 55 g ; Cu,10 g ; Fe, 35 g ; Co, 250 mg ; Se, 150 mg ; I, 1 g ; Mn, 60 g and anti-oxidant, 10 g.

** According to NRC, 1994.

Table (2): Live body weight, live body weight gain and feed intake (Mean ± SE) of broiler chicks as affected by dietary commercial zinc–methionine supplementation.

Items	Control	0.3gZn Met/ Kg diet	0.4gZn Met / Kg diet	0.5gZn Met / Kg diet	Over all mean
Live body weight, g (LBW):					
21 days	678.1 ±15.6	683.9 ±15.8	689.3 ±15.6	695.5 ±15.8	686.7±7.86
28 days	957.1 ±22.8^{c}	974.0 ±23.2^{b}	1036.6±22.8^{ab}	1043.4±23.2^{a}	1002.8±11.5
35 days	1374.9±33.6^{B}	1398.7±34.1^{B}	1521.5±33.6^{A}	1493.8±34.1^{A}	1447.2±16.9
42 days	1767.6±43.6^{b}	1793.8±44.8^{b}	1855.7±44.8^{a}	1954.1±44.2^{a}	1842.8±22.2
49 days	2224.9±54.7^{B}	2251.1±57.2^{B}	2307.9±58.0^{B}	2473.2±56.3^{A}	2314.3±28.3
Live body weight gain, g (LBWG):					
21-28 days	278.9 ±12.1^{B}	290.2 ±12.2^{B}	347.3 ±12.1^{A}	347.9 ±12.2^{A}	316.1 ±6.1
29-35 days	417.9 ±19.6	424.6 ±19.9	484.9 ±19.6	450.4 ±19.9	444.4 ±9.9
36-42 days	392.7 ±21.3^{B}	389.3 ±21.9^{B}	342.1 ±21.9^{B}	460.3 ±21.6^{A}	396.1 ±10.8
43-49 days	457.3 ±20.0	475.3 ±21.2	450.4 ±21.2	519.0 ±20.6	475.5 ±10.4
21-49 days	1546.8±44.8^{B}	1562.1±46.8^{B}	1613.3±47.6^{B}	1777.9±46.1^{A}	1625.0±23.2
Feed intake, g (FI):					
21-28 days	694.3 ±0.2^{C}	694.2 ±0.2^{D}	749.9 ±0.2^{A}	749.6±0.2^{B}	722.0 ±0.01
29-35 days	888.7 ±0.2^{C}	886.3 ±0.2^{D}	916.8 ±0.2^{B}	943.9±0.2^{A}	908.9 ±0.01
36-42 days	972.1 ±19.9^{B}	742.1 ±20.2^{D}	916.5 ±19.9^{C}	1082.8±20.2^{A}	928.4 ±10.0
43-49 days	1111.0±0.9^{C}	1208.9±0.9^{A}	1040.4±0.9^{D}	1128.8±0.9^{B}	1122.3±0.05
21-49 days	3666.1±19.9^{B}	3531.5±20.2^{C}	3623.6±19.9^{B}	3905.2±20.2^{A}	3681.6±10.0

a, …c, and A,… D, values in the same row within the same item followed by different superscripts are significantly different (at $P \le 0.05$ for a to c ; $P \le 0.01$ for A to D).

Table (3): Feed conversion, crude protein conversion and caloric conversion ratio (Mean ± SE) of broiler chicks as affected by dietary commercial zinc-methionine supplementation.

Items	Control	0.3gZn Met / Kg diet	0.4gZn Met / Kg diet	0.5gZn Met / Kg diet	Over all mean
Feed conversion (FC):					
21-28 days	2.49±0.43	2.39±0.43	2.16±0.43	2.15±0.43	2.28±0.21
29-35 days	2.13±0.15	2.09±0.15	1.89±0.15	2.10±0.15	2.05±0.07
36-42 days	2.48±0.20^{a}	1.91±0.21^{c}	2.68±0.21^{a}	2.35±0.20^{ab}	2.35±0.10
43-49 days	2.43±0.19	2.54±0.20	2.31±0.20	2.18±0.19	2.36±0.10
21-49 days	2.37±0.08	2.26±0.08	2.25±0.08	2.20±0.08	2.27±0.04
Crude protein conversion (CPC):					
21-28 days	0.710±0.09	0.532±0.09	0.484±0.09	0.480±0.09	0.552±0 .05
29-35 days	0.497±0.03	0.480±0.03	0.419±0.03	0.499±0.03	0.474±0 .02
36-42 days	0.497±0.04^{a}	0.384±0.04^{c}	0.559±0.04^{a}	0.471±0.04^{ab}	0.478±0.02
43-49 days	0.502±0.03	0.507±0.04	0.454±0.04	0.409±0.04	0.468±0 .02
21-49 days	0.552±0.03	0.474±0.04	0.484±0.04	0.465±0.04	0.494±0 .02
Caloric conversion ratio (CCR):					
21-28 days	9.59±1.20	7.19±1.21	6.53±1.20	6.47±1.21	7.44±0.60
29-35 days	6.71±0.42	6.48±0.42	5.65±0.42	6.74±0.42	6.39±0.21
36-42 days	8.62±0.63^{a}	6.65±0.64^{c}	9.69±0.64^{a}	8.16±0.64^{ab}	8.28±0.32
43-49 days	8.70±0.58	8.80±0.62	7.87±0.62	7.09±0.60	8.11±0.30
21-49 days	8.40±0.49	7.26±0.52	7.50±0.52	7.12±0.50	7.57±0.25

a, …c, values in the same row within the same item followed by different superscripts are significantly different (at P ≤ 0.05 for a to c).

Table (4): Growth rate, performance index and chemical analysis of carcass meat% (Mean ± SE) of broiler chicks as affected by dietary commercial zinc-methionine supplementation.

Items	Control	0.3gZn Met / Kg diet	0.4gZn Met / Kg diet	0.5gZn Met / Kg diet	Over all mean
Growth rate (GR):					
21-28 days	0.388±0.01^{B}	0.348±0.01^{B}	0.404±0.01^{A}	0.404±0.01^{A}	0.373±0.006
29-35 days	0.354±0.01	0.358±0.01	0.380±0.01	0.355±0.01	0.362±0.007
36-42 days	0.252±0.01^{A}	0.242±0.01^{A}	0.201±0.01^{B}	0.266±0.01^{A}	0.240±0.007
43-49 days	0.230±0.01	0.234±0.01	0.216±0.01	0.235±0.01	0.229±0.005
21-49 days	0.774±0.02^{b}	0.765±0.02^{b}	0.792±0.02^{b}	0.868±0.02^{a}	0.800±0.012
Performance index (PI):					
21-28 days	39.61±2.41^{B}	41.75±2.44^{B}	49.08±2.40^{A}	49.26±2.44^{A}	44.93±1.21
29-35 days	66.95±4.44	68.61±4.50	82.28±4.44	73.20±4.50	72.76±2.23
36-42 days	73.30±7.82^{B}	115.37±5.05^{A}	71.77±8.05^{B}	85.12±7.93^{B}	68.39±3.98
43-49 days	93.23±5.74^{c}	91.10±6.09^{c}	103.1±6.09^{ab}	115.8±5.90^{a}	100.8±2.98
21-49 days	68.27±3.73	80.19±3.96	73.68±3.78	80.84±3.84	75.74±1.91
Chemical analysis of carcass meat %.					
Moisture	75.52±0.26	75.71±0.26	75.80±0.26	75.16±0.26	75.55±0.13
Protein	17.62±0.64	16.65±0.64	17.25±0.64	18.36±0.64	17.47±0.32
Fat	2.36±0.36	2.77±0.36	2.79±0.36	3.17±0.36	2.78±0.18
Ash	0.930±0.020	0.858±0.02	0.879±0.02	0.861±0.02	0.882±0.01
NFE	3.57±0.55	4.00±0.55	3.28±0.55	2.45±0.55	3.33±0.72

a, …c, and A,… B, values in the same row within the same item followed by different superscripts are significantly different (at $P \leq 0.05$ for a to c ; $P \leq 0.01$ for A to B).

Table (5): Carcass traits (Mean ± SE) of broiler chicks as affected by dietary commercial zinc-methionine supplementation.

Items	Control	0.3gZn Met / Kg diet	0.4gZn Met / Kg diet	0.5gZn Met / Kg diet	Over all mean
Carcass traits					
Liver %	1.91±0.10	2.08±0.10	1.95±0.10	2.03±0.10	1.99±0.05
Gizzard%	1.89±0.20	2.30±0.20	1.80±0.20	2.03±0.20	2.01±0.10
Spleen %	0.144±0.02	0.171±0.02	0.139±0.02	0.136±0.02	0.148±0.01
Heart %	0.498±0.02	0.459±0.02	0.430±0.02	0.468±0.02	0.47±0.01
Total giblets %	4.45±0.28	5.04±0.28	4.32±0.28	4.67±0.28	4.62±0.14
Abdominal fat%	2.51±0.35	2.08±0.35	2.38±0.35	2.52±0.35	2.36±0.17
Carcass %	71.42±1.39	65.95±1.39	66.18±1.39	66.58±1.39	67.54±0.70
Dressing %	75.87±1.45	71.00±1.45	70.51±1.45	71.25±1.45	72.16±0.73
Specific gravity	1.032±0.002	1.030±0.002	1.031±0.002	1.029±0.002	1.03±0.001

Table (6): Plasma constituents (Mean ± SE) of broiler chicks as affected by dietary commercial zinc-methionine supplementation.

Items	Control	0.3gZn Met / Kg diet	0.4gZn Met / Kg diet	0.5gZn Met / Kg diet	Over all mean
Serum constituents					
Calcium MM/L[1]	4.48±1.06	3.98±1.06	4.61±1.06	3.90±1.06	4.24±0.58
Triglycerides MM/L	3.07±0.52	3.16±0.52	2.12±0.52	2.15±0.52	2.62±0.26
Cholesterol MG[2]%	110.58±9.25	105.77±9.25	116.35±9.25	109.62±9.25	110.58±4.62
AST (GOT) U/ ML[3]	39.50±4.98	39.50±4.98	36.50±4.98	31.50±4.98	36.55±2.49
ALT (GPT) U/ ML	$9.00±3.34^{b}$	$15.50±3.34^{b}$	$33.00±3.34^{a}$	$14.50±3.34^{b}$	18.00±1.67
Total protein G/L[4]	65.56±10.9	40.00±10.9	68.89±10.9	56.67±10.9	57.78±5.45
AlbuminG/L	22.44±4.45	29.71±4.45	21.86±4.45	27.69±4.45	25.43±2.23
Globulin G/L	43.11±11.6	10.29±11.6	47.03±11.6	28.98±11.6	32.35±5.78
Glucose MM/L	15.05±1.82	10.51±1.82	10.80±1.82	14.36±1.82	12.68±0.911

a, …b, values in the same row within the same item followed by different superscripts are significantly different (at P ≤ 0.05 for a to b).
[1] Millimoll / Liter, [2] Milligram%, [3] Unit / Milli, [4] Gram / Liter.

Table (7) : Economical efficiency of broiler chicks as affected by dietary commercial zinc-methionine supplementation.

Treatments / Items	Control	0.3gZn Met / Kg diet	0.4gZn Met / Kg diet	0.5gZn Met / Kg diet
Average feed intake (Kg/bird) a	3.666	3.531	3.623	3.905
Price / Kg feed (P.T.) * b	105.76	106.66	106.96	107.26
Total feed cost (P.T.) = a x b = c	387.72	376.62	387.52	418.85
Average LBWG (Kg/ bird) d	2.224	2.251	2.307	2.473
Price / Kg live weight (P.T.) ** e	700	700	700	700
Total revenue (P.T.) = d x e = f	1556.8	1575.7	1614.9	1731.1
Net revenue (P.T.) = f - c = g	1169.08	1199.08	1227.38	1312.25
Economical efficiency =(g /c) ***	3.02	3.18	3.17	3.13
Relative efficiency ****	100	105.59	105.04	103.90

***Based on average price of both starter and finisher diets during the experimental time.**
**** According to the local market price at the experimental time.**
***** Net revenue per unit feed cost.**
****** Assuming economical efficiency of the control group equals 100.**

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الملخص العربى

Broiler, Zinc-Methionine, Carcass Characteristics.

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