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# Effect of threonine and zinc alone or in combination on growth performance of broiler chickens

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**Abstract**--Broiler chickens' growth performance may be affected by the body health and the level of challenges; Therefore, this Study was aimed to evaluated the was aimed to investigate the effect of threonine(Thr.) from the jefo Co.Canada and zinc (Zn.) from the Zinpro Co.USA as an important factor that regulates intestinal amino acid metabolism. The experiment period was five weeks started from 7/12/2021 to 11/1/2022 carried out in special felid. A total of 200 straight run one-day broiler chickens (Ross 308) were divided randomly to four groups (50/group) with 2 replicates (25 birds/pen). The control group (CON.) fed basal diet without any additives. The second group was fed the basal diets with high level calculated (%0.9) Threonine. The third group was fed the basal diets with level calculated (% 0.1) Zinc. The fourth group was fed the basal diets with (% 0.9) Threonine and was fed the basal diets with (% 0.1) Zinc. Feed and water provided add libitum to the end of the study. The growth performance of broilers were varies greatly ( $P \leq 0.05$ ) among (Thr-Zn), (Threonine) and (Zinc) in the feed intake, body weight, feed conversion ratio and body weight gain ( $P \leq 0.05$ ) groups compared with (Con.). In conclusion, adding a mixture of Threonine and Zinc to their base diet can improve the growth performance broiler chickens of Ross(308).

**Keywords**--broiler, performance, immune response, intestinal morphology.

**Introduction**

Nutrition plays a major role of gainful broiler chickens production and on an average it accounts for about 80–90% of the total cost of production (NAFIS,

2017). Modern broiler chickens can potentially attain 2 kg of body weight by consuming 3 kg of feed within 5 weeks (Choct *et al.*, 2009). Chickens require precise levels of dietary nutrients particularly amino acids and energy (Kim *et al.*, 2007). Additionally, optimal dietary amino acid contents (Webel *et al.*, 1996), are prerequisite to support gut functions. A healthy gut plays a key role in an ideal growth performance of broilers because it supports a better digestion and absorption of nutrients (Qaisrani *et al.*, 2015). A healthy gut is, therefore, necessary for profitable poultry production. Villi height and crypt depth are important. Longer villi and shorter crypts are usually considered as markers of a healthy and well functioning gut (Qaisrani *et al.*, 2015).

Threonine (Thr), the third limiting amino acid after lysine and methionine in corn-soy diets, is an indispensable amino acid for broiler chickens (Berres *et al.*, 2007). The influence of Threonine on growth parameters in the feed intake, body weight, feed conversion ratio and body weight gain in broiler chickens (Qaisrani *et al.*, 2018). Dietary Thr, above the requirements, promotes the growth performance (Trevisi *et al.*, 2015). Zinc (Zn) is the most commonly added trace mineral in broiler chicken feeds. Zinc is an essential nutritional trace element for all forms of life as it plays an important role in numerous biological processes (Faa *et al.*, 2008; Ranaldi *et al.*, 2013; Bonaventura *et al.*, 2015). It is important for growth metabolism and oxygen free radical scavenging (Kietzmann and Braun 2006; Feng, Ma *et al.*, 2010; Liu, Lu *et al.*, 2011). Previous studies have shown that the effect of zinc from different sources, organic (e.g., zinc amino acid) on production performance varies (Schlegel, Sauvante *et al.*, 2013). The bioavailability of organic zinc is higher than that of inorganic zinc. A number of researchers have used organic Zn (Burrell *et al.*, 2004). In broiler diets and found an increase in body weight and body weight gain. The role of gut health is pivotal in broiler performance from hatch to the point of harvest (Shannon and Hill., 2019). Zinc is an important dietary factor which regulates amino acid and protein metabolism in animals (Wang *et al.*, 2009). Accordingly, the aim of the current study combined effects of Thr and Zn are suggested on the intestinal absorption and digestion, growth performance according to Rodríguez-Yoldi *et al.* (1993). The aims of this study are to identify the following. The current study is aimed to study the effect of threonine and zinc alone or in combination their effect on growth performance of broiler chickens by estimation of :-To study threonine and zinc alone or in combination on weekly live body weight, feed intake, weight gain, and feed conversion ratio of broiler chickens.

## **Literature Review**

### **Threonine**

Similarly, Kheiri and Alibeyghi (2017) reported that the broiler chickens fed diets containing 0.90% Thr had 1.1% increased FI, 3.2% higher body weight gain and 1.7% better FCR compared with those birds fed control diets. Min *et al.* (2017) conducted a trial to investigate the effect of Thr on broiler chickens growth performance from 1 to 42 days of age by using total 0.75, 0.94 and 1.12% Thr of the diet, along with a control diet containing total 0.62% Thr. The results revealed that broiler chickens fed diet containing 0.75% Thr had 1.6% higher FI, 6% higher average daily gain and 4.2% better FCR compared with the birds fed control diet.

Chen *et al.* (2017), similarly, used 0.88 and 1.08% of total dietary Thr, along with a control diet containing 0.77% Thr to evaluate its effect on growth performance of broilers. Birds fed with diet containing 0.88% dietary Thr had 0.6% higher body weight gain, 2.8% better FCR, and 1.0% reduced feed intake compared to those fed with the control diet. Valizade *et al.* (2016) investigated the effect of 0.675 and 0.843% of total dietary Thr on growth performance of broilers in comparison with a control diet containing 0.641% Thr. Diet containing 0.843% dietary Thr supported better growth performance in broilers, with a 4.7% better FCR and 1.0% increase in body weight gain, compared with those fed control diet.

The improved growth performance with higher level of Thr may be due to provision of higher level of Thr required for an ideal growth performance. Comparing the effect of 0.74, 0.81, 0.88 and 0.96% total dietary Thr on growth performance, Eftekhari *et al.* (2015) reported that diet containing 0.81% total dietary Thr supported a 5.1% better FCR compared with the birds fed NRC recommended (0.74% total dietary) Thr content. In another study, Shirzadegan *et al.* (2015) evaluated the effect of 0.74, 0.79, 0.81 and 0.84% of total dietary Thr on growth performance of broiler chickens. The study concluded that broiler chickens fed diets with 0.84% total Thr performed better and resulted in a 3.1% increase in feed intake, 10.5% higher body weight gain and 4.7% better FCR compared with those fed diets containing 0.74% total dietary threonine.

Ospina-Rojas *et al.* (2013) investigated the effect of 0.70% (control) and 0.77% total dietary Thr levels on broiler chickens performance. The results indicated that broiler chickens fed with 0.77% dietary Thr had good performance with 1.3% higher body weight gain and 1.4% better FCR and a 0.2% reduction in feed intake compared with those receiving control diet. Corzo *et al.* (2007) evaluated the influence of feeding six levels, namely, 0.51 (control), 0.58, 0.65, 0.72, 0.79 and 0.86% of total dietary Thr on broiler chickens growth performance. This dose response study indicated that 0.86% dietary Thr was ideal for broiler chickens growth performance that resulted in 103% higher body weight gain, 133.7% better FCR and 13.3% lower feed intake during 22–42 d compared with those fed the control diet. Ciftci and Ceylan (2004) evaluated the effect of four levels (0.54 (control), 0.60, 0.66 and 0.72%) of total dietary Thr on growth performance of broilers. The 0.72% dietary Thr supported 23.2% increase in FI, 27.1% increases in body weight and 3% better FCR compared with the control diet. Data on the influence of different levels of dietary Thr on growth performance of broiler chickens are summarized.

## **Zinc**

A number of researchers have used organic Zn (Burrell *et al.*, 2004) in broiler diets and found an increase in body weight and body weight gain. Higher biological efficacy of ZnMet in terms of increase in the growth was observed if Zn is bound by fibre and phytates in basal diets (Jahanian *et al.*, 2008a; 2008b). Ao *et al.* (2006) observed that a chelated Zn proteinate (Bioplex® zinc) increased body weight gain and feed intake with increasing levels (from 5 to 40 mg/kg diet). The study concluded that supplemental Zn required for optimal broiler growth rate during starting phase (1-21 days of age) was 9.8 mg/kg diet. Moreover, Jahanian *et al.* (2008a) conducted an experimental trial to investigate the potential of

dietary organic sources (Zn-lysine, Zn-methionine and Znacetate) on the broiler performance and carcass traits. The result showed a significant increase in the feed intake with organic Zn inclusion, while the overall feed conversion improved with 80 mg organic Zn/kg diet. Liu *et al.* (2013) stated that Zn proteinate had a significant beneficial effect on weight gain in broilers. Recently, Jahanian and Rasouli (2015) observed that partial substituting of inorganic Zn by ZnMet improved the weight gain of broiler chickens. Many studies have been performed to examine the impact of different organic zinc sources on poultry feed intake and conversion efficiency. (Hess *et al.*, 2001) added 40 mg/ kg zinc from three different sources (ZnMet, Zn-Lys or ZnMet plus Zn-Lys) to broiler diets. They found improved FCR when organic zinc-amino acid complexes were used in feed for female broilers. The better FCR was observed in earlier weeks (1.66 in average for zinc amino acid complexes vs. 1.73 for the control); this may be attributed to proper feathering, as reported by (Jahanian *et al.*, 2008a).

## Materials and Methods

### Managment of Broiler chickens

This study was carried out in a special field, from 7/12/2021 to 11/1/2022. Broiler Chickens were obtained from commercial hatchery from Kerbala province (hatchery Al-Baz). Feed and water was given *ad libitum*. All brioler chickens received starter diet from (1-10 days) and grower diet from (11-35 days). The starter and grower diet of the experiment were prepared as crumble were met the NRC requirements (NRC, 1994).

Table 3-1  
Ingredients and nutrients composition of Starter and Grower diets

Ingredients/gram	Starter%(1-10 days) kg	Grower %(11-35 days)kg
Corn oil	1.5	2.5
Soybean	33.5	33
Corn	57.5	60
Flour	5	2
Provimi Premix	2.5(starter premix 3088)	2.5(finisher premix 3110)
Calculation composition	100%	100%
Crude protein CP%	21	20.27
Crude fiber CF%	2.77	2.74
Calcium Ca%	0.961	0.919
AV-phosphorus	0.42	0.371
ME poultry kcal/kg	2800	3100
AV-methionine	0.47	0.42
AV-TSAA	0.74	0.68
AV-threonine	0.63	0.61
AV-Lysine	1.18	0.98
Electrolytes	263	241.12

### **The feed additives used in the experiment**

- Threonine (Thr) : use used threonine synthetic source from Jefe Co.Canada. Website <https://panjiva.com/Jefe-Nutrition-Inc/44332272>
- Zinc (Zn) : ues used zinc from the Zinpro Co.USA.
- Website <https://www.zinpro.com/products/>

### **Preparation of poultry farm**

After cleaning the walls, ceiling and floor by clean water and disinfectant. All windows were opened and all ventilation exhausted fans were switched for ensuring removal of toxic gases completely before chicks admittance, Wateres and feeders were cleaned with disinfectant, then distributed to the groups. All hall groups were provided with suitable litter (wood sawdust), lighting and ventilation were controlled according to recommendation. All chicks were reared according to Aviagen guide (Aviagen, 2020).

### **Experimental design**

A total of 200 straight run one-day broiler chickens (Ross 308) were divided randomly to four groups (50/group) with 2 replicates. Each replicate was subdivided to 25 birds/pen as show in (Table 3-3). The control group (Con) fed basal diet without any additives. The second group was fed the basal diets with level calculated (0.9%) dried Threonine. The third group was fed the basal diets with level calculated (0.1%) dried Zinc. The last was combination group (Thr-Zn) fed the basal diets with calculated ( 0.9%) dried Threonine and was fed the basal diets with level calculated ( 0.1%) dried Zinc.This experiment period was five weeks started from 7 /12/2021 to 11/1/2022. Feed and water provided to the end of the study.

### **Parameters studied**

#### **Weekly broiler chickens performance**

(Body weight, body weight gain, feed intake, and feed conversion ration) during experimental period 7,14,21,28 and 35 days old.

#### **Broiler chickens performance**

##### **Mean weekly body weight (BW) (gm/birds)**

The weight of broiler body was calculated every week by weighing chicks individually at one day old and at end of each week by sensitive balance. Mean body weight was measured from the total weight of all chicks divided on the number of chicks (Al-fayadh and Naji, 1989).

##### **Weekly mean weight gain (WG) (gm/birds)**

The mean body weight gain was measured weekly for each group by recording the weight gain at the beginning of the week and at the end depending on the following equation. Mean weekly weight gain=body weight at the end of the week-body weight at the beginning of the week (Al-fayadh and Naji, 1989).

### Weekly feed intake (F.I.) (gm)

The feed intake has been measured each week depending on weighting the remaining feed at each end of the week and substrate from the feed that offered at the beginning of the same week, taking with concern the number of the dead chicks and number of feeding days. According to this equation which was mentioned by (AL-fayadh and Naji, 1989). For calculated the food intake of chicks.

### Feed conversion Ratio (F.C.R):

Feed Conversion Ratio was calculated weekly for each group up to the end of experiment. (AL-fayadh and Naji, 1989) was reported the equation for measurement of FCR.

$$FCR = \frac{\text{mean weekly feed intake(gm)}}{\text{mean weekly body weight gain(gm)}}$$

### Statistical analysis

Data was analyzed as one-way ANOVA by using the general linear model (GLM) procedure with SPSS 22.0 software (**Corp, 2011**). Four treatments means were separated by using a “protected” Duncan’s analysis at level ( $P < 0.05$ ).

### Results

#### Broiler performance

#### Threonine and Zinc alone or in combination on weekly live body weight, feed intake, weight gain, and feed conversion ratio of broilers

Tables (4-1,2,3,4) Live body weight, feed intake, weight gain and feed conversion rate are shown separately. The results showed a significant increase ( $P \leq 0.05$ ) compared with (the control group) the live body weight, feed intake, the weight gain and the rate of food conversion for the (Thr) and (Zn) groups and combination groups (Thr+Zn).

Table 4-1  
showed threonine and zinc and their combination on weekly live body weight (gm/bird) of broilers

Group age	Con	Thr	Zn	Thr + Zn
1 st day (gm)	44.42±0.09	44.50±0.08	44.42±0.09	44.52±0.09
7 th . (gm)	180.67±2.5 C	200.22±0.8 B	198.66±1.27 B	209.84±0.37 A
14th . (gm)	417.14±4.08 D	491.10±3.32 B	462.78±2.25 C	536.32±1.94 A
21th (gm)	907.58±8.29 D	1054.86±5.77 B	1009.59±6.06 C	1147.74±3.73 A

28th . (gm)	1472.74±10.23 D	1663.60±3.86 B	1604.34±4.10 C	1817.78±6.66 A
35th . (gm)	2081.50 ±11.69 D	2333.72±4.34 B	2249.60±6.37 C	2540.70±4.50 A

**Different letters in the same row showed a significant difference at (P≤0.05)**

CON = fed basal diet without supplement. Thr = fed basal diet with 0.9% dried Threonine. Zn = fed basal diet with 0.1% Zinc. Thr+Zn = fed basal diet with 0.9% dried Threonine and 0.1% Zinc.

Table 4-2  
showed threonine and zinc and their combination on weekly feed intake of broilers

Group Age	con	Thr	zinc	Thr+zn
1 st wk. (gm)	175.708±0.622 D	226.34±0.303 B	210.618±0.39 7 C	253.76±0.363 A
2 nd wk. (gm)	354.14±0.665 D	407.45±0.482 B	380.18±0.450 C	444.02±0.549 A
3 rd wk. (gm)	740.41±0.766 D	907.38±0.812 B	862.57±0.818 C	945.018±0.682 A
4 th wk. (gm)	971.62±0.596 D	1086.74±1.60 9 B	1046.59±0.67 0 C	1141.57±0.643 A
5 th wk. (gm)	1124.83±1.448 D	1225.98±1.45 4 B	1186.94±1.26 7 C	1304.05±1.280 A
Cumulative (gm)	3366.71±3.044 D	3853.91±2.12 8 B	3686.91±1.12 9 C	4088.42±1.991 A

**Different letters in the same row showed a significant difference at (P≤0.05)**

CON = fed basal diet without supplement. thr= fed basal diet with 0.9% dried threonine .Zn = fed basal diet with 0.1% Zinc . Thr-zn = fed basal diet with 0.9% dried threonine and 0.1% Zinc.

Table 4-3  
Showed threonine and zinc and their combination on weekly weight gain (gm/birds) in broiler

Group Age	Con	Thr	zinc	Thr+zn
1 st wk. (gm)	136.34±2.63 C	155.72 ±0.78 B	154.24 ±1.29 B	165.32±0.39 A

2 nd wk. (gm)	236.38±4.74 D	290.88±3.58 B	264.12±2.66 C	326.48±2.04 A
3 rd wk. (gm)	490.44±9.65 C	563.76 ±5.60 B	546.72 ±6.66 B	611.42 ±3.88 A
4 th wk. (gm)	565.16 ±7.06 C	608.74 ± 4.86 B	594.84 ±3.09 B	670.04±4.20 A
5 th wk. (gm)	609.76±3.25 D	670.12 ±0.83 B	645.26 ±4.85 C	722.92 ±8.34 A
Cumulative (gm)	2038.08±11.77 D	2289.22±4.30 B	2205.18±6.38 C	2496.18±4.50 A

**Different letters in the same row showed a significant difference at (P≤0.05)**

CON = fed basal diet without supplement. Thr= fed basal diet with 0.9% dried threonine. Zn = fed basal diet with 0.1% Zinc. Thr-zn = fed basal diet with 0.9% dried threonine and 0.1% Zinc

Table 4-4

Showed threonine and zinc and their combination on weekly feed conversion ratio of broilers

Group Age	Con	Thr	Zinc	Thr+Zn
1 st wk. (gm)	1.29±0.027 D	1.453±0.008 B	1.365±0.011 C	1.53±0.003 A
2 nd wk. (gm)	1.50±0.028 A	1.401±0.018 AB	1.44±0.013 B	1.36±0.008 C
3 rd wk. (gm)	1.610±0.029 A	1.512 ±0.016 C	1.578±0.018 AB	1.545±0.010 BC
4 th wk. (gm)	1.785±0.021 A	1.72±0.013 BC	1.759±0.008 AB	1.704±0.01 C
5 th wk. (gm)	1.844±0.01 A	1.8295±0.002 A	1.819± 0.015 A	1.804±0.021 A
Cumulative (gm)	1.683±0.010AAA A	1.6522±0.002 B	1.672±0.004 A	1.637±0.003 B

**Different letters in the same row showed a significant difference at (P≤0.05)**

CON = fed basal diet without supplement.thr= fed basal diet with 0.9% dried threonine .Zn = fed basal diet with 0.1% Zinc . Thr-zn = fed basal diet with 0.9% dried threonine and 0.1% Zinc.

## Discussion

### Broiler performance

#### Study of threonine and zinc and their combination on weekly live body weight, feed intake, weight gain, and feed conversion ratio of broilers

The results of the current study were showed the live body weight, feed intake, weight gain, and feed conversion ratio in tables (4-1,2,3,4) were increased significantly ( $P \leq 0.05$ ) in the (Thr-Zn), (Thr), and (Zn) groups respectively compared with the control. The results in (table 4-1) indicated that the (Thr-Zn) group recorded the highest mean body weight among treatments, while in the age 35<sup>th</sup> days we found a significant increase of live body weight as mean  $\pm$  SE (2540.70  $\pm$  4.50) in the (Thr-Zn) group rather than control group as mean  $\pm$  SE (2081.50  $\pm$  11.69). The results in (table 4-2) indicated that the (Thr-Zn) group recorded a significant ( $P \leq 0.05$ ) increased in feed intake and improved in the feed conversion ratio as compared with the control group the results were recorded as mean  $\pm$  SE (1304.05 $\pm$ 1.280), greater than (1124.83 $\pm$ 1.448) in the control group.

Threonine led to improve of BW, WG, FI and FCR may be because of enhance body health and Gut health by promoting mucin secretion act to improve barrier function and competitive exclusion of pathogenic bacteria. A ratio Thr %0.9 showed a significant increase of daily BW, WG, FI and FCR of broilers for the overall period of 1-35 days of age, reported that the broiler fed diets containing 0.9% Thr led to improved of BW, WG, FI and FCR compared with those birds fed control diets. In broiler chickens, Chee *et al.* (2010b) showed that an excess intake of Thr can increase the amount mucin in intestine. In the current study, Thr reduced pathogens in the cecal contents, indicating that Thr exerted a beneficial effect on the gut microbiota population, which was possibly associated with enhanced mucin synthesis and immunoglobulin secretion resulting from Thr (Ren *et al.*, 2014; Trevisi *et al.*, 2015).

The positive effects of Thr supplementation on growth performance in broiler chickens may be due to the involvement of Thr supplementation in the development of intestinal mucosa as well as in digestive enzymes function (Dozier *et al.*, 2001). A healthy gut plays a key role in an ideal growth performance of broilers because it supports a better digestion and absorption of nutrients. Mucins are a glycoprotein, that are the main component of mucous layers that cover intestinal epithelium. Mucin is secreted by goblet cells. The main protect the intestinal cells from digestive enzymes and acids (Kim & Ho 2010). Thr represents more than 40% of their amino acid residues (Bengmark & Jeppsson, 1995). Thr can improve intestinal morphology

Thus, uses that high level (%0.9) of Threonine can significantly improve BW, WG, FI and FCR. increasing Mucins and the activity of digestive enzymes and improve immune in broiler chickens. Also Zinc organic led to improve of BW, WG, FI ,FCR and Immunity may be because of enhance body health and Gut health and improve barrier function and competitive exclusion of pathogenic bacteria. The results showed that Zn organic to improve growth performance body weight and immunity at level (0.1%) had the best result. Therefore, it positively affects intestinal activity and increases digestive enzymes to enhance digestion and

intestinal absorption. The positive effects of organic Zn (Burrell *et al.*, 2004) in broiler diets and found an increase in body weight and weight gain. The result showed a significant increase in the feed intake with organic Zn inclusion, while the overall feed conversion improved with organic Zn diet. Liu *et al.* (2013) stated that Zn had a significant beneficial effect on weight gain in broilers. A ratio Zn (0.1%) showed a significant increase of daily weight gain and feed efficiency of broilers for the overall period of 1-35 days of age with supplementing broiler diets with zinc is a common industry practice (Sunder *et al.*, 2008). Moreover, it plays an important role in wound healing and in restoring the integrity of damaged tissues (Batal *et al.*, 2001; Jahanian and Rasouli, 2015). Zinc which plays a crucial role in the protection of cells against oxygen radicals free (Oteiza, 2012).

The effect of zinc on carcass characteristics, such as dressing percentage, carcass yield and carcass composition of broilers. Meat products are one of the main sources of dietary zinc in humans (Ma and Betts, 2000; Terre's *et al.*, 2001). According to American Zinc Association (Washington DC, VA, USA), the average zinc content in white meat from poultry are 5.2 and 1.5 mg100 g<sup>1</sup>, respectively. The dark meat of a chicken has more zinc than the light meat (Health Line, 2007). Furthermore, zinc in meat products has a high bioavailability (Hortin *et al.*, 1993; Lonnerdal., 2000). several developed and undeveloped countries have recommended daily intakes of zinc slightly higher or lower than these recommendations (Hussein and Brugge man, 1997; Brown *et al.*, 2001; Terree' s *et al.*, 2001). Moreover, Jahanian *et al.* (2008a) add to organic (Zn) led to improve of on the broiler performance and carcass traits. Thus, the combined effects from Thr-Zn to enhance the digestive and absorptive capacity and antioxidant status in the intestine (Hong *et al.*, 2015) are led to improve WG, BW. Combined effects of Thr and Zn are suggested on the intestinal absorption and, according to Rodríguez-Yoldi *et al.* (1993), Zinc amino acid (such as zinc threoninate) can improve availability and absorption by reducing antagonism.

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