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Effects of Zinc and Probiotic on The Small Intestine and Carcass Characterization of Broiler Chickens

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Abstract

Zinc is a crucial trace mineral for birds to function appropriately in enzyme systems and be engaged in protein synthesis, glucose metabolism, and many other metabolic activities. Probiotics are used to enhance the gastrointestinal flora and assist in maintaining a healthy digestive tract. Two hundred straight-run one-day-old broiler chicks Ross 308 were divided randomly into four groups (50 birds), each divided into two replicates containing (25) chicks. The control group (C) was provided with a base meal without any additives, the second group (A) was fed on a basil diet containing 1.5 g/kg Zn, the third group (B) was fed on a basal diet containing 1g/kg probiotic, the fourth group (AB) fed on basil diet contain a combination of Zn 1.5g/kg + probiotic 1g/kg (AB). The result revealed a significant increase ($p \leq 0.05$) in the mean intestinal villi area and carcass characterization in the AB group compared with other groups. In summary, our work recommends that a combination of Zn 1.5g/kg + probiotic 1g/kg could improve the properties of intestine and carcass characterization in broiler chicks.

Keywords: Organic zinc, Probiotic, Intestinal villi, Carcass characterization, Broiler chickens.

Introduction

Zinc is an essential dietary element that regulates the metabolic processes of amino acids and proteins in the intestinal tract of broiler chickens. It has been shown that a zinc shortage has a deleterious effect on the integrity of gut health by increasing intestinal permeability [1]. Compared to inorganic sources, the organic forms of zinc utilized in chicken diets are more readily absorbed, which may impact the development of intestinal villi [2]. Renewing, which prepares cells for absorption, is caused by the movement of cells from the crypts to the villus tip. The length of the villus crescent is related to the length of the digestive and absorption-appropriate enzyme crescent, which is brought on by Zn supplements [3]. Also, zinc deficiency is linked to a reduction in the height of the villus [4; 5].

A probiotic is a living bacteria that, when consumed by the host in sufficient quantities, is beneficial to the host's health. Lactic acid and bifid bacteria are the most common probiotic strains [6]. Its metabolism is slowed to survive in harsh conditions like high or low pH and very high or low temperatures. The effects of these microorganisms on the host include a decrease in intestinal pH due to acid production, an increase in intestinal antioxidant capacity, stimulation of the gut-associated immune system, and stimulation of intestinal intraepithelial lymphocytes [7]. Production attributes are beneficial for economic performance monitoring and for evaluating animal health. The effect of probiotics as alternative substances when added to broiler feed may depend on the breeding system to generate differences in the hygienic conditions for growth promoters. Broiler supplements with probiotics were significantly higher in live body weight gain and carcass yield [8]. According to [9], probiotic bacteria have active enzyme factories (protease, amylase, and lipase) suited for digesting proteins, lipids, carbohydrates, and co-factors; this improves digestion, metabolism, and nutrient utilization, which increases feed conversion efficiency.

According to [9] probiotics aid in metabolising various vitamins, including Biotin, B1, B2, and K, essential for growth. Broiler supplements with probiotics were significantly higher in live body weight gain and carcass yield [10]. Probiotics enhance the effect of endogenous enzymes that one of many beneficial bacteria naturally produce within the gastrointestinal tract [10].

Materials and method:

Experiment design.

Two hundred straight-run one-day-old broiler chicks Ross 308 were divided randomly into four groups (50 birds), each divided into two replicates containing (25) chicks. The control group (C) was fed a basal diet without any additives, the second group (A) was fed d basal diet with 1.5 g/kg Zn, the third group(B) fed on basal diet with 1g/kg probiotic, the fourth group (AB) fed on basal diet with a combination of Zn 1.5g/kg + probiotic 1g/kg. On day 35, samples were collected from the intestines (duodenum, jejunum and ilium), the group was examined, and the gut was weighed. All chicks were fed adlibitum, and the diet was formulated according to Avian Company's requirements. Table (1) shows the composition of the diet in three phases.

Table (1): Composition of broiler chickens' diet (kg per ton)

Content	Starter (control)	Grower (control)	Finisher (control)
Corn	519	556	596
Soya bean	408	370	325
Soya bean oil	29	35	43
Limestone	10	9	6
Mcp1	9	5	5
Premix2	25	25	25
Energy kcal/kg	3000	3000	3200
C p%	23	21.5	20
Lysine%	1.23	1.14	1.04
Methionine%	0.51	0.49	0.47
TSAA%	0.80	0.77	0.73
Threonine%	0.75	0.70	0.63
Calcium%	0.98	0.87	0.77
Av. phosphate	0.50	0.40	0.40

1)Mcp: Greenphos, phosphorous 22.7%, and calcium 16%. BAF (animal feed company, ADNA, TURKEY)
2)Effective material in 1 kg of premix2: vitamin E 50 000 mg; vitamin D 3 800 000 IU; niacin 12 000 mg; pantothenic acids 3 000 mg; riboflavin 1 800 mg; thiamn 600 mg; menadion 800 mg; ascorbic acid 50 000 mg; folic acid 400 mg; vitamin A 2 500 000 IU; biothin 40 mg; pyridoxin 1 200 mg; vitamin B12 10 mg; cholín 100 000 mg; betain 50 000 mg; Mn 20 000 mg; Zn 16 000 mg; Fe 14 000 mg; Cu 2 400 mg; Co 80 mg; I 200 mg; Se 50 mg.

Statistical analysis:

The common linear model (GLM) algorithm of SPSS 22.0 software was used to analyze the data as a one-way ANOVA. A "protected" Duncan's analysis with a level (0.05) was used to differentiate the four treatment means.

Results and discussions

The current study shows a significant ($p \leq 0.05$) increase in intestinal villi area in the combination group comber with other groups, such study Zinc increase villi length by producing new cells that increase the space of the intestine and increase absorption in the intestine [11]. As in Tables (2,3,4)

Table (2): Duodenum villi histometric measurements

Groups	Villi area(mm)2±**S.D** Mean		Villi width(mm) ±**S. D** Mean		Villi length(mm) ±**S. D** Mean	
C	0.04	0.18	0.02	0.12	0.1	1.48
A	0.03	0.17	0.02	0.11	0.15	1.61C
B	0.03	0.26A	0.02	0.15A	0.13	1.71A
AB	0.03	0.31A, B	0.02	0.18A, B	0.13	1.71A

Different letters among groups showed a significant difference at ($p \leq 0.05$).

The control group © fed basal diet without any additives, (A) contain 1.5 g/kg Zn, (B) contain 1g/kg probiotic, (AB) contain combination of Zn 1.5g/kg + probiotic 1g/kg.

Table (3): Jejunum villi histometric measurements

Group	Villi area (mm2)		Villi width (mm)		Villi length(mm)	
	Mean **±S.D**		Mean **±S.D**		Mean **±S.D**	
C	0.04	0.12	0.03	0.11	0.13	1
A	0.04	0.13	0.03	0.12	0.07	1.06
B	0.05	0.20A	0.04	0.15A	0.06	1.29A
AB	0.04	0.31A,D	0.03	0.22A,D	0.06	1.45A,D

Different letters among groups showed a significant difference at ($p \leq 0.05$). The control group (C) fed basal diet without any additives, (A) contain 1.5 g/kg Zn, (B) contain 1g/kg probiotic, (AB) contain combination of Zn 1.5g/kg + probiotic 1g/kg.

Table (4): Ileum villi histometric measurements

Group	Villi area (mm2)	Mean ±S.	Villi width (mm)	Mean ±S.D	Villi length(mm)	Mean ±S.D
C	0.01	0.09	0.01	0.09	0.1	0.95
A	0.03	0.12	0.02	0.16C	0.16	0.79
B	0.03	0.19A	0.04	0.20A	0.13	0.94
AB	0.03	0.25A,B	0.03	0.23A,B	0.1	1.10A,B

Different letters among groups showed a significant difference at ($p \leq 0.05$).
The control group (C) fed basal diet without any additives, (A) contain 1.5 g/kg Zn, (B) contain 1g/kg probiotic, (AB) contain combination of Zn 1.5g/kg + probiotic 1g/kg.

Table (5): Crypt depth histometric measurements (mm)

Group	Ilium Mean ±S.D		jejunum Mean ±S.D		Duodenum Mean ± S.D	
C	0.03	0.19	0.02	0.17	0.03	0.18
A	0.04	0.27A	0.06	0.28A	0.08	0.28A
B	0.05	0.29A	0.03	0.24A	0.02	0.23A
AB	0.03	0.37A,D	0.03	0.39A,D	0.05	0.37A,D

Different letters among groups showed a significant difference at ($p \leq 0.05$).
The control group (C) fed basal diet without any additives, (A) contain 1.5 g/kg Zn, (B) contain 1g/kg probiotic, (AB) contain combination of Zn 1.5g/kg + probiotic 1g/kg.

The results of the current study showed that the crypt width and villus height in the intestine in Table (5) were increased significantly ($P \leq 0.05$) in the (AB) compared with the other group, (A) and (B) groups, respectively compare with the control(C). The results indicated that the (AB) group recorded the highest mean crypt width and villus among treatments. We found a significant increase in the crypt width and villus height as (mean ± SE) according to the duodenum (0.71±0.13), (0.18±0.02) and jejunum (1.45 ±0.06), (0.22±0.4) and ileum (1.10±0.23), (0.39±0.3) respectively. Compared with the control group recorded duodenum (1.48±0.10), (0.12±0.2) and jejunum (1.00±0.13), (0.11±0.3) and ileum (0.95±0.10), (0.9±0.01) respectively.

According to[12]organic zinc at the level produced the greatest results for raising villus height, crypt width, and the ratio of villus height to crypt width. Renewing, which prepares cells for absorption, is caused by the movement of cells from the crypts to the villus tip. According to [12] the length of the villus' crescent is related to the presence of an enzyme that makes organic Zn easy to digest and absorb. The field of probiotics has furthermore seen tremendous expansion and innovation due to the manufacturing of enzymes by various bacterial strains. Since it can generate keratinize, B-mannanase, amylase, alkaline, and proteases, Bacillus licheniformis strains have been widely employed in the industry (13]. The jejunum, ileum, and villus width of the duodenum were raised, as well as the villus height and villus width of the ileum, and the expression of mucin mRNA in the ileal portion was improved when native lactic acid bacteria probiotics were added to the diets. [14] conclude these findings that lactic acid bacteria may promote the growth of intestinal epithelium and control the mucosal barrier created by mucin in the small intestine of birds.

Table (6): Effect zinc and probiotic on carcass characteristic

Groups / parameter	T4	T3	T2	T1
Live body Wight	2516.14±16.41A	2251.04±2.50C	2334.02±5.56B	2077.72±10.84D
Carcass Without feather	2329.94±15.19A	2084.46±2.32C	2161.30±5.15B	1923.88±10.07D
Without visra	1846.84±12.04A	1652.26±1.84C	1713.17±4.08B	1525.04±7.96D
with edible	2001.64±8.79A	1765.46±4.30C	1826.97±10.09B	1615.24±11.01D
Gizzard	75.40±3.32A	59.00±4.22B	59.80±3.08B	42.40±3.24C
Liver	60.20±2.42A	41.20±1.40B	39.40±3.72B	36.60±1.87B
Heart	19.20±1.98A	13.00±.25B	14.60±1.81B	11.20±.47B

Different letters between groups showed a significant difference at (p≤ 0.05).
The control group (C) fed basal diet without any additives, (A) contain 1.5 g/kg Zn, (B) contain 1g/kg probiotic, (AB) contain combination of Zn 1.5g/kg + probiotic 1g/kg.

Zinc plays a role in collagen synthesis, and deficiencies of this nutrient result in reduced skin collagen production [15]. The growth performance, which is the net balance of protein production and breakdown, impacts an animal's capacity for growth. Any factor that enhances synthesis and/or decreases breakdown will result in more significant muscle growth, whereas any factor that decreases synthesis and/or increases breakdown will cause muscular atrophy [16]. The significance of Zn in gastrointestinal health and functionality has been the subject of several investigations. By affecting intestinal permeability, zinc deficiency has been shown to have a deleterious impact on gut integrity [17].

Furthermore, dietary probiotics have been utilized to control the immunological response in Broiler. They may stimulate the immune system, reduce inflammation, eliminate gastrointestinal tract pathogens, and lessen processed broiler carcasses' bacterial contamination. Broiler supplements with probiotics significantly increased live body weight gain and carcass content [10]. Also, the balanced interaction between the intestinal microbiota, epithelium and immune system provides resistance to enteric pathogens [18] by keeping cells more firmly connected in distinct units, organic and higher quantities of Zn combined with the inorganic source enhanced meat quality [18]. To encourage collagen production, protein synthesis, and proper enzyme activity, all factors in meat quality [19]. The result of the current study showed an increase significantly ($P \leq 0.05$) increase in life body Weight and carcass with or without visceral, gizzard, liver, and heart in the combination group (AB) compared with other groups. The differences are similar between (A and B). It is considered less significant for the control group (A). The examination is done at the age of broiler chickens 36 days. We notice an increase in the size of the heart, and this is due to the excellent use of organic zinc, as it is included in the synthesis of protein and helps in building the muscles of the bird's body. This increase in the size of the heart is appropriate for the weight increase of the bird's body.

When body weight increases, the size of the heart may naturally increase to meet the needs of the larger body. An increase in body weight is usually associated with an increase in muscle mass and adipose tissue volume in the body, which requires the heart to increase in strength and efficiency to pump blood to these additional areas [20] As broiler chickens consume a high-energy diet to promote rapid growth, the gizzard adapts to the increased workload by growing and developing stronger muscular walls. This adaptation allows for better grinding and digestion of the feed aiding in nutrient absorption [21].

Conclusion

Depending on the results study finding, there for conclusions are as follows:
1. Dietary combination may enhance the intestinal health of chicken broilers by increasing the efficacy of villus length, villus depth, and villus area.
2. Their combination improves the carcass characterization in broiler chickens.

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