Academic International Journal of Veterinary Medicine
ISSN: 2984-7753
Aca. Intl. J. Vet. Med. 2023; 1(1) 15-21
Journal homepage: www.aipublishers.org/aijvm

Influence of Zinc and Probiotics on Productive Performance, Immune Response and Mineral Content in Muscle of Broiler Chickens

Sara S. Haylan*[1], Yasser J. Jameel[2] & Latif I. Kadhim[3]
College of Veterinary Medicine, University of Kerbala, Karbala, Iraq
*Corresponding author: Email: mayarsara2014@gmail.com

(Received 10 December 2022, Revised 15 February 2023, Published 15 April 2023)

Abstract
Zinc (Zn) is most commonly added to broiler chickens' feeds. It is an essential nutritional trace element for all forms of life. Probiotics are used to replenish 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 equal groups of 50 chicks, each divided into two replicates containing 25 chicks. The control group (T1) was fed a basal diet without any additives, the second group (T2) fed on a basal diet containing 1.5 g/kg Zn, the third group (T3) fed on a basal diet containing 1g/kg probiotic, the fourth group(T4) fed on a basal diet have a combination of Zn 1.5g/kg + probiotic 1g/kg. The result revealed a significant increase ($p \leq 0.05$) in the mean body weight values, body weight gain, feed intake and feed conversion ratio in the combination group compared to the other groups. Likewise, this group showed significantly increased antibody titers against Newcastle and infections bursal disease vaccines and minerals contained in the pectoral muscle of broilers. In summary, our work recommends that a combination of Zn 1.5g/kg + probiotic 1g/kg could improve productive performance, immunity and chemical composition of minerals.

***Keywords**:* Organic zinc, Probiotic, Productive performance, Minerals, Broilers.

Introduction:

The digestive tract is crucial for effectively breaking feed into its constituent parts for optimum nutritional absorption. Digestion and nutrition absorption will be hampered by poor gut health, hurting bird performance and well-being. Maintaining intestinal health is crucial to raising poultry that performs at the highest level. Good gut health in poultry allows birds to fend off sickness when treated appropriately [1].

Zinc (Zn) is the trace mineral most frequently added to the feed for broiler chickens, and it is a vital nutritional trace element for all living things because of its crucial involvement in various biological functions. Its significance to the health and part of the gastrointestinal tract is that a zinc shortage has a deleterious effect on the integrity of gut health by increasing intestinal permeability [2, 3]. A type of glutaminergic neurons store zinc in specialized synaptic vesicles before releasing it as a neuromodulator in an activity-dependent way. Zinc is also crucial for neurogenesis, synaptogenesis, neuronal development, and neurotransmission.
According to [4, 5], it may be utilized in broiler chicken diets as either organic (such as zinc protein, zinc amino acid, or zinc picolinate) or inorganic (such as zinc chloride, zinc sulfate, or

zinc oxide). Insufficient bone mineralization, skeletal deformity, and decreased weight gain are all effects of Zn deficiency in broiler chicks [6]. Probiotic bacteria have been used as growth promoters in poultry and livestock feed to increase feed conversation efficiency and improve immune responses and growth performance [7 , 8]. Probiotics are frequently used as a feed additive in poultry production systems for enhancing production performances and health status. As a live enzyme factory (Protease, amylase, lipase), probiotics provide digestible proteins, enzymes, vitamins, and co-factors that aid in better digestion, metabolism, and nutrient utilization. This improved absorption and digestion of carbohydrates, protein, and fats increases feed conversion efficiency.
Another supporting hand is provided by the metabolism of minerals and the production of vitamins (Biotin, B1, B2, and K), essential for growth characteristics and metabolism [9]. Adding probiotics has been discovered to enhance feed conversion, improve birds' immune system and growth performance by effects on intestinal function and morphology, and resistance to enteric pathogens in animal diets [10]. The present study was designed to evaluate the effect of zinc and probiotic combination on productive performance, immune response and chemical composition of minerals in the muscle of broilers.

Material & Methods:

Experiment design:

Two hundred straight-run one-day-old broiler chicks Ross 308 were divided randomly into four groups (50 birds) per group, each divided into two replicates containing 25 chicks. The control group (T1) was fed a basal diet without any additives, the second group (T2) provided on a basal diet containing 1.5 g/kg Zn, the third group(T3) was fed on a basal diet containing 1g/kg probiotic, the fourth group(T4) provided on a basal diet have a combination of Zn 1.5g/kg + probiotic 1g/kg. The chicken's weight and feed intake were collected at the end of every week. At the back of the experiment (day 35), pectoral muscles and blood samples were collected to measure meat's immune response and mineral content. 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	Grower	Finisher
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
Cp%	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

Mcp:Greenphos,phosphorous 22.7% and calcium16% .BAF(animal feed company, ADNA, TURKEY)
Effective material in 1 kg of premix2: vitamin D 3 800 000 IU; Mn 20 000 mg; Zn 16 000 mg; vitamin E 50 000 mg; niacin 12 000 mg; pantothenic acids 3 000 mg; riboflavin 1 800 mg; thiamin 600 mg; menadione 800 mg; ascorbic acid 50 000 mg; folic acid 400 mg; vitamin A 2 500 000 IU; biotin 40 mg; pyridoxin 1 200

mg; vitamin B12 10 mg; cholín 100 000 mg; betain 50 000 mg; Fe 14 000 mg; Cu 2 400 mg; Co 80 mg; I 200 mg; Se 50 mg.

Statistical analysis:

The general linear model (GLM) approach in SPSS 22.0 software [11] was used to analyse the data's 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 the combination group's live body weight and weight gain compared to the other groups. In contrast, zinc and probiotic groups show a significant increase compared to the control group, as shown in Tables (2 and 3). This result is in agreement with The results of the current study are consistent with [12] in that the combination group showed a significant increase in feed intake and a reduction in feed conversation ratio when compared to the other groups, while the zinc and probiotic group showed a significant boost when in contrast to the group serving as the control.

Table (2): Influence of Zinc, probiotics and their combination on broilers live body weight(gm) (Mean ± SE)

Weeks \ Groups	T1	T2	T3	T4
Day1	42.64±1.6A	42.76±1.8A	42.54±1.3A	42.28±1.5A
Bw1	183.6±1.1C	199.2±2.0B	196.7±1.4B	209.4±1.1A
Bw2	430.88±4.8C	463.38±14.5B	463.16±2.5B	528.16±6.7A
Bw3	908.3±8C	1047±10B	1042 ±17B	1108±20A
Bw4	1446 ±16C	1634.40±11B	1621 ± 16B	1724.00±16A
Bw5	2077 ± 10.84C	2334 ± 5.5B	2318 ±24 B	2516±16A

Different letters among groups showed a significant difference at ($p \leq 0.05$). The control group (T1) was fed a basal diet without any additives, (T2) contained 1.5 g/kg Zn, (T3) contained 1g/kg probiotic, (T4) contained a combination of Zn 1.5g/kg + probiotic 1g/kg.

Table (3): Influence of Zinc, probiotics and their combination on broilers weight gain(gm) (Mean ± SE)

Weeks \ Groups	T1	T2	T3	T4
WG week 1	140.96±1.1C	165.48±1.9B	154.20±1.3B	167.16±1.0A
WG week 2	247.28±5.2B	268.8±12.5B	266.42±3.7B	318.72±5.7A
WG week 3	477.46±10.8B	584.5±21.2A	579.4±18.5A	579.94±15.1A
WG week 4	538.16±12.7B	586.5±19 AB	579.3±17 AB	615.90±24.7A
WG week 5	613.22±16.4C	699.62±11B	666.2±21 BC	792.14±25.8A

Different letters among groups showed a significant difference at ($p \leq 0.05$). The control group (T1) was fed a basal diet without any additives, (T2) contained 1.5 g/kg Zn, (T3) held 1g/kg probiotic, (T4) had a combination of Zn 1.5g/kg + probiotic 1g/kg.

Table (4): Influence of Zinc, probiotics and their combination on broilers' weekly Feed intake(gm) (Mean ±SE)

Groups / Weeks	T1	T2	T3	T4
FI week 1	203.27±5.68C	225.76±.36B	220.05±5.8B	239.51±4.26A
FI week 2	389.71±11.8C	404.48±1.1B	380.1±2.4BC	447.62±3.61A
FI week 3	784.44±15.3C	824.5±11.3B	865.68±9.6A	846.75±6.5AB
FI week 4	872.68±.77AB	888.55±1.8A	848.85±4.9B	865.99±16AB
FI week 5	1132.59±1AB	1057.74±18B	1063.53±28B	1146.65±28A

Different letters among groups showed a significant difference at ($p \leq 0.05$)
The control group (T1) was fed a basal diet without any additives, (T2) contained 1.5 g/kg Zn, (T3) contained 1g/kg probiotic, (T4) contained a combination of Zn 1.5g/kg + probiotic 1g/kg.

Table (5): Influence of Zinc, probiotics and their combination on broilers Feed conversion ratio (Mean ±SE)

Groups / Weeks	T1	T2	T3	T4
FCR week 1	1.48±.01A	1.44±.01A	1.43±.0.3A	1.41±.02A
FCR week 2	1.60±.04A	1.51±.07AB	1.42±.01B	1.40±.03B
FCR week 3	1.66±.04A	1.42±.04B	1.50±.05B	1.46±.03B
FCR week 4	1.62±.03A	1.52±.04AB	1.47±.05AB	1.41±.05B
FCR week 5	1.80±.04A	1.49±.01BC	1.58±.03B	1.45±.04C

Different letters among groups showed a significant difference at ($p \leq 0.05$)
The control group (T1) was fed a basal diet without any additives, (T2) contained 1.5 g/kg Zn, (T3) contained 1g/kg probiotic, (T4) contained a combination of Zn 1.5g/kg + probiotic 1g/kg.

The current study shows a significant ($p \leq 0.05$) increase in Immunological parameters in the combination group as compared with the other group, while there is a powerful ($p \leq 0.05$) increase in the probiotic group as compared with the zinc and control group, on the other hand, zinc group show significant ($p \leq 0.05$) increase as compared with the control group as shown in table (6)

Table (6): Influence of Zinc, probiotics and their combination on immune response against ND and IBD of broilers

Groups / Parameters	T1	T2	T3	T4
ND	2878.0±49.89D	3190.0±93.45C	3428.0±80.14B	3778.0±79.72A
IBD	169.40±5.5 C	245.00±6.1 B	261.00±3.9 B	343.80±15.0 A

Different letters among groups showed a significant difference at ($p \leq 0.05$)
The control group (T1) was fed a basal diet without any additives, (T2) contained 1.5 g/kg Zn, (T3) contained 1g/kg probiotic, (T4) contained a combination of Zn 1.5g/kg + probiotic 1g/kg.

The current study shows a significant ($p \leq 0.05$) increase in Mg in (the T2) group compared with the other group. At the same time, there is no significant difference when compared to the combination group. as shown in Table (7). The Cu shows no significant difference between the experiment groups, as shown in Table (7). Zinc showed a significant ($p \leq 0.05$) increase in the combination group compared to the other groups. At the same time, there is no considerable difference between the zinc group and the probiotic group.

In contrast, the control group showed a significant ($p \leq 0.05$) decrease compared to the other groups. As shown in Table (7). Fe shows a significant ($p \leq 0.05$) increase in the combination group as compared with the zinc and probiotic group; the control group showed a substantial decrease as compared with the other groups. as shown in Table (7)

Table (7): Influence of Zinc , probiotic and their combination on mineral contained in muscle µg/kg: (Mean ± SE)

	T1	T2	T3	T4
Mg	7.07±.05C	7.55±.07A	7.23±.01BC	7.54±.12AB
Cu	50.88±1.7A	51.85±1.7A	50.20±1.1A	52.80±1.6A
Zn	57.94±7.4C	162.67±21.0A	96.41±14.9BC	121.36±11.2AB
Fe	200.58±7.2A	215.20±5.7A	219.10±9.4A	218.80±6.7A

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

The control group (T1) was fed a basal diet without any additives, (T2) contained 1.5 g/kg Zn, (T3) contained 1g/kg probiotic, (T4) contained a combination of Zn 1.5g/kg + probiotic 1g/kg.

Zinc is necessary for DNA synthesis, an essential step in cell division. Specifically, zinc is required for the activity of many enzymes involved in DNA replication, repair and transcription. It may also play a role in regulating the cell cycle, which is the sequence of events that leads to cell division and increases immune cell production [13]. Zinc facilitates the absorption of iron in the intestines through various mechanisms, and it aids in the synthesis and secretion of a protein called hepcidin, which regulates iron metabolism.

Zinc deficiency can lead to decreased hepcidin levels, impairing iron absorption. Also, zinc promotes the activity of an enzyme called ferroportin, which transports iron across the intestinal cells and into the bloodstream. By enhancing ferroportin function, zinc helps facilitate the movement of iron from the intestinal lumen into the body [14]. Further, more zinc plays a role in the structure and function of the intestinal lining. It helps maintain the integrity of the intestinal cells. It supports the development of microvilli, which are finger-like projections on the surface of the intestines that increase the porous area. This enhanced porous surface allows for improved uptake of iron and other nutrients [15].

Probiotics can increase the expression and activity of proteins involved in iron uptake, such as divalent metal transporter 1 (DMT1). This upregulation of iron transporters facilitates the absorption of dietary iron in the intestines [16]. Also, Probiotics have anti-inflammatory properties and can help alleviate gut inflammation. Chronic inflammation can impair iron absorption, so reducing inflammation promotes better iron uptake [17]. It can compete with other intestinal bacteria for zinc-binding sites in the gut. This competition reduces the binding of zinc to less beneficial bacteria, allowing more zinc to be available for absorption by the body [18]. Moreover, Probiotics support a healthy gut environment, which includes maintaining the integrity of the intestinal lining. A healthy gut lining promotes efficient absorption of nutrients, including zinc [19].

Also, Probiotics can influence the expression and activity of zinc transporters in the intestines. These transporters facilitate the movement of zinc across intestinal cells, ultimately increasing its absorption [20].

Conclusion

Adding a combination of zinc and probiotics can increase body weight, weight gain, and feed intake. Also, it can improve the immune state of the birds and increase iron, mg and zinc absorption in pectoral muscle.

References.

1. Ravindran V, Abdollahi MR. Nutrition and digestive physiology of the broiler chick: State of the art and outlook. Animals. 2021;11(10):2795. doi:10.3390/ani11102795
2. Nguyen HTT, Morgan N, Roberts JR, Wu SB, Swick RA, Toghyani M. Zinc hydroxychloride supplementation improves tibia bone development and intestinal health of broiler chickens. Poultry Science. 2021;100(8):101254.
3. Klasing KC. Nutritional diseases. Diseases of poultry. 2013:1203-1232.
4. Fatholahi A, Khalaji S, Hosseini F, Abbasi M. Nano-Bio zinc synthesized by Bacillus subtilis modulates broiler performance, intestinal morphology and expression of tight junction's proteins. Livestock Science. 2021;251:104660.
5. Maret W, Sandstead HH. Zinc requirements and the risks and benefits of zinc supplementation. Journal of trace elements in medicine and biology. 2006;20(1):3-18.
6. Sahraei M, Janmmohamdi H, Taghizadeh A, Cheraghi S. Effect of different zinc sources on tibia bone morphology and ash content of broiler chickens. Advances in Biological Research. 2012;6(3):128-132.
7. Apata DF. Growth performance, nutrient digestibility and immune response of broiler chicks fed diets supplemented with a culture of Lactobacillus bulgaricus. Journal of the Science of Food and Agriculture. 2008;88(7):1253-1258.
8. Al-Khalaifah HS. Benefits of probiotics and/or prebiotics for antibiotic-reduced poultry. Poultry science. 2018;97(11):3807-3815.
9. Dhama K, Singh SD. Probiotics improving poultry health and production: an overview. Poultry Punch. 2010;26(3):41.
10. Tang SGH, Sieo CC, Ramasamy K, Saad WZ, Wong HK, Ho YW. Performance, biochemical and haematological responses, and relative organ weights of laying hens fed diets supplemented with prebiotic, probiotic and synbiotic. BMC veterinary research. 2017;13:1-12.
11. Corp I. IBM SPSS statistics for windows, version 22.0. IBM Corp Armonk, NY. 2011.
12. Ogbuewu IP, Modisaojang-Mojanaga MMC, Mokolopi BG, Mbajiorgu CA. A meta-analysis of responses of broiler chickens to dietary zinc supplementation: feed intake, feed conversion ratio and average daily gain. Biological Trace Element Research. 2023;201(5):2491-2502.
13. Xiao G. Molecular physiology of zinc in Drosophila melanogaster. Current Opinion in Insect Science. 2022;100899.
14. Ma L, Terwilliger A, Maresso AW. Iron and zinc exploitation during bacterial pathogenesis. Metallomics. 2015;7(12):1541-1554.
15. Yang Z, Liao SF. Physiological effects of dietary amino acids on gut health and functions of swine. Frontiers in veterinary science. 2019;6:169.
16. Garcés V, Rodríguez-Nogales A, González A, Gálvez N, Rodríguez-Cabezas ME, García-Martin ML, Dominguez-Vera JM. Bacteria-carried iron oxide nanoparticles for treatment of anemia. Bioconjugate Chemistry. 2018;29(5):1785-1791.
17. Deriu E, Liu JZ, Pezeshki M, Edwards RA, Ochoa RJ, Contreras H, Raffatellu M. Probiotic bacteria reduce salmonella typhimurium intestinal colonization by competing for iron. Cell host & microbe. 2013;14(1):26-37.

18. Scarpellini E, Balsiger LM, Maurizi V, Rinninella E, Gasbarrini A, Giostra N, Rasetti C. Zinc and gut microbiota in health and gastrointestinal disease under the COVID-19 suggestion. Biofactors. 2022;48(2):294-306.
19. Judkins TC, Archer DL, Kramer DC, Solch RJ. Probiotics, nutrition, and the small intestine. Current Gastroenterology Reports. 2022;22:1-8.
20. Islam T, Albracht-Schulte K, Ramalingam L, Schlabritz-Lutsevich N, Park OH, Zabet-Moghaddam M, Moustaid-Moussa N. Anti-inflammatory mechanisms of polyphenols in adipose tissue: Role of gut microbiota, intestinal barrier integrity and zinc homeostasis. The Journal of Nutritional Biochemistry. 2023;115:109242.