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Effect of Nano Zinc on Lying Hen's Physiological Traits Exposed to Coccidia Challenge

Saad Mohammed Hussein Kazem[1], Atheer Kareem Kadhim[2]
[1]College of Agriculture, Al-Qasim Green University, Department of Animal Production, Iraq.
[2]Al-Furat Al-Awsat Technical University- Al-musaib Technical institute- Medical laboratory techniques

ABSTRACT

From July 1st to January 1st, 2025, this study was carried out in a chicken farm in Babylon Governorate to investigate the use of nano-zinc for coccidiosis treatment. 360 laying hens were utilized, divided into four treatments of 90 laying hens each, and then further divided into replicates of 30 laying hens each. The treatments were T1 (no addition), T2 (80 ppm nano-zinc/L), T3 (100 ppm nano-zinc/L), and T4 (120 ppm nano-zinc/L). The results show: significant ($P<0.05$) increase for T1 treatment in cholesterol and triglyceride in 28 days, 56 days and, 28 days respectively, significant ($P<0.05$) increase for T1 treatment in ALT in 28 days and, 56 days respectively compared other treatments, while in AST (28 and 56 days) noted not significant deference among treatments, significant ($P<0.05$) increase for T2, T3, and T4 treatments in total protein at 28 and 56 days, significant ($P<0.05$) increase for T2 treatment in IgG at 28 days, at 56 days significant ($P<0.05$) increase for T3 treatment in IgM.

KEYWORDS: nano zinc, lying hens, physiological, coccidia challenge, animal parasites.

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Corresponding Author:
Saad Mohammed Hussein Kazem

INTRODUCTION

Coccidiosis is among the most prevalent intestinal parasitic illnesses used in poultry farming. It is due to the type Eimeria parasites that attack the intestinal wall and destroy the intestinal cells and this leads to clinical effects of blood diarrhea, malabsorption, loss of weight and low production of eggs in the laying hens. Eimeria tenella, Eimeria acervulina, and Eimeria maxima are some of the species of these high economic value organisms of poultry (Aljebory and Naji, 2021 a&b; Aljohani, 2024). The losses in production in poultry industry due to coccidiosis are immense all over the world. It has a great influence on the growth rate, egg quality, and mortality rate and involves a high economic burden on the farmers, especially in the intensive layer hen systems (Blake et al., 2020; Lee et al., 2022). The basis of control of coccidiosis in the past has been the use of antiparasitic drugs such as toltrazuril and amprolium along with feed and water preventative programs to prevent outbreaks. However, resistance to drugs and limitation posed by the use of some chemical compounds have compelled researchers to identify other or additional solutions based on the application of modern technologies (Mustafa et al., 2024). Nanotechnology is one of these contemporary solutions regarding animal treatment since nanoparticles possess the antimicrobial and antiparasitic effect due to another mechanism than the common drugs do. One of them is the nanoparticle ZnO-NPs that is promising due to its high surface area, as well as, its high degree of biological activity in comparison with the conventional zinc (Akhavan-Salamat and Ghasemi, 2019). Recent studies have established that ZnO-NPs can also increase the severity of coccidiosis infection by decreasing the number of oocysts released into the feces and, therefore, reducing the number of parasites in the environment (El-Shall et al., 2021). The factors that influence the improvement in the overall intestinal performance of the infected birds are the enhanced production performance which is characterized by weight gain and resistance to infection as compared to the untreated and infected control, and also the higher antioxidant activity and reduced intestinal tissue injury. This was supported by a single pilot study that indicated that mortality rates of chickens with coccidiosis decreased when feeding it was supplemented with ZnO-NPs, and the microbiological and pathological symptoms were altered to a similar extent compared to a control group that received diclazuril as a supplement, not to mention that performance indicators, i.e., red blood cell count and antioxidant levels, increased (El-Maddawy et al., 2022; Al-Jumaili et al., 2024). Despite the good results of ZnO-NPs, which have been observed in the preliminary studies, it is necessary to mention that the use of ZnO-NPs as an inexpensive and clean technology in the laying hens has been discussed in the framework of comprehensive investigation to identify the optimal dosages, mode of action and potential side effects on the health of the bird and safety of the product (e.g. eggs). Therefore, the suggested study will investigate how zinc nanoparticles that are incorporated in drinking water affect some of the physiological changes exhibited by laying hens.

MATERIALS

In this study conducted in a layer hen farm in the Babylon Governorate but between 1 st July and 1 st January to establish the impacts of the nano-zinc addition to the drinking water of the laying hen. The reared chickens were floor reared and diagnosed to have coccidiosis. The hens were confirmed and then divided into 4 treatments containing 90 hens each with the process repeated three more times to bring the total of hens per treatment to 30. Treatments were as follows:

T1: No addition
T2: Add 80 ppm nano-zinc/L.
T3: Add 100 ppm nano-zinc/L.
T4: Add 120 ppm nano-zinc/L.

The laying hens were fed on 120g /laying hen meal that had 16 percent crude protein and 2850 kcal energy. Physiological characteristics were assessed using the (Al-Jebory et al., 2023& 2024), SAS 2012 program and Duncan 1955 test were used to identify the significant differences between treatments.

RESULTS AND DISCUSSION

1- cholesterol and Triglyceride

Table 1: shown the effect of study on cholesterol and triglyceride, noted significant (P<0.05) increase for T1 treatment in cholesterol and triglyceride in 28 days, 56 days and, 28 days respectively compared other treatments, while in triglyceride (56 days) noted not significant deference among treatments.

Table 1: Effect of neem leaves powder on cholesterol and Triglyceride of lying hens exposed to coccidia challenge

Treatments	Cholesterol		Triglyceride	
	28 days	56 days	28 days	56 days
T1	217.32±1.16 a	155.12±0.30 a	141.16±0.27 a	170.52±6.25
T2	124.79±2.77 b	130.88±2.67 b	123.43±1.61 b	172.11±1.30
T3	148.27±3.40 b	123.61±8.80 b	89.73±2.53 c	174.46±5.03
T4	133.85±1.69 b	117.79±2.56 b	101.15±4.55 b	169.99±7.16
Significant	*	*	*	N.S

*(P<0.05), N.S: Not significant

2- ALT and AST enzyme

Table 2: shown the effect of study on ALT and AST, noted significant (P<0.05) increase for T1 treatment in ALT in 28 days and, 56 days respectively compared other treatments, while in AST (28 and 56 days) noted not significant deference among treatments.

Table 2: Effect of neem leaves powder on ALT and AST of lying hens exposed to coccidia challenge

Treatments	ALT		AST	
	28 days	56 days	28 days	56 days
T1	7.92±0.26 a	5.12±1.30 a	131.96±1.27	150.22±8.25
T2	3.29±0.37 b	9.88±2.07 b	133.43±8.61	152.11±9.31
T3	4.17±0.42 b	3.61±6.10 b	139.73±7.53	154.06±8.93
T4	3.45±0.61 b	4.79±4.46 b	131.45±4.55	151.19±7.46
Significant	*	*	N.S	N.S

*(P<0.05), N.S: Not significant

3- **Total protein and Albumin**

Table 3: shown the effect of study on total protein and albumin, noted significant (P<0.05) increase for T3 treatment total protein at 28 days compared T1 and T2 treatments, while at 56 days significant (P<0.05) increase for T3, T4 and T5 treatments compared T1 treatment, while in albumin (28 and 56 days) noted not significant deference among treatments.

Table 3: Effect of neem leaves powder on Total protein and Albumin of lying hens exposed to coccidia challenge

Treatments	Total protein		Albumin	
	28 days	56 days	28 days	56 days
T1	4.12±0.16 c	4.02±0.03 b	2.46±5.01	2.12±4.75
T2	5.29±0.27 b	5.81±0.07 a	2.63±5.11	2.21±3.41
T3	6.07±0.09 a	5.91±0.01 a	2.53±4.33	2.16±3.83
T4	5.85±0.31 ab	5.89±0.06 a	2.65±3.65	2.29±3.36
Significant	*	*	N.S	N.S

*(P<0.05), N.S: Not significant

4- **Total protein and Albumin**

Table 4: shown the effect of study on IgG and IgM, noted significant (P<0.05) increase for T2 treatment in IgG at 28 days compared to T1 and T3 treatments, while at 56 days not significant deference among treatments, in IgM (28 days) noted not significant deference between treatments, at 56 days significant (P<0.05) increase for T3 treatment compared to other treatments and increased the T2 and, T4 treatment on TI.

Table 4: Effect of neem leaves powder on IgG and IgM of lying hens exposed to coccidia challenge

Treatments	IgG		IgM	
	28 days	56 days	28 days	56 days
T1	1.02±0.06 c	1.52±2.53	1.36±0.01	1.42±0.05 c
T2	1.99±0.07 a	1.41±3.07	1.33±0.11	1.71±0.01 b
T3	1.67±0.03 b	1.51±1.01	1.33±0.33	2.26±0.03 a
T4	1.75±0.01 ab	1.59±1.22	1.35±0.65	1.69±0.06 b
Significant	*	N.S	N.S	*

*(P<0.05), N.S: Not significant

Infection of the coccidioid parasite eliminates the intestinal lining and mucosa leading to intra-intestinal bleeding and the decrease in the concentration of immune proteins. This in turn reduces the uptake of nutrients and worsens the digestion of nutrients that result in poor egg production and poor quality eggs. Meanwhile, the disease burden contributes to the emergence of high level of lipids in the organism, significant changes in the lipid profile, and high levels of liver enzymes AST and ALT engaged in the generation of non-carbohydrate-based energy. This also reduces productive performance of laying hens (El-Shall et al., 2021).

This might be due to the action of the nano-zinc on production of sex steroid hormones and the capacity of the nano-zinc to alter lipid profile, AST and ALT enzyme levels and protein level in the nano-zinc treatment in comparison to the control one (Brown and Pentland, 2007). It is also explicable by the fact that zinc assists in the production of proteins since it increases the concentration of the thyroid hormones (Park et al., 2011). The pathogenicity of the coccidiosis and the stress status of the birds might have explained the high level of lipids in T1 control when compared to the control as it led to the production of energy relying on non-carbohydrate as a source against the disease. Zinc may also be inhibitively antioxidant that inhibits the oxidation catalysts like in the form of the metal ions by inhibiting the discharge of the oxidizing agents out of the tissues, thus breaking the chain reaction of the free radicals and preventing its production and formation especially by way of the reactive oxygen species which are the free radicals. This inhibits the oxidative damage of liver membranes and polyunsaturated cell membrane fatty acids, which is carried out to preserve the selective permeability of the liver membrane. It works to prevent the leakage of the enzymes of the cell to the outside (Dani et al., 2008). Another antioxidant is nano zinc as it participates in the production of metallothionein, the protein that inhibits free radicals, which are caused by the pathological oxidative stress. Zinc also prevents the formation of the free radicals by substituting part of the minerals that zinc can substitute in the binding sites e.g. iron and copper (Prasad and Kucuk, 2002). Besides this, zinc can be used to make sure that the cell membrane is not damaged since it is an antioxidant (Cunningham-Rundles et al., 1990; Al-Saeedi et al., 2023& 2025).

CONCLUSION

In this study concluded that the ZnO-NPs were demonstrated to be useful in anticoccidial activity under different experimental conditions of monospecies and mixed Eimeria infections. It appears to be the most efficient with high doses of oral administration (60 mg/kg) as acute treatment or with lower doses (20 ppm) as prophylaxis. Similarities are present in the antioxidant enhancement effect and the anti-inflammatory effect and gut integrity enhancement regardless of the particle size or the synthesis process, although biosynthesized formulations may prove advantageous. In this instance, growth promotion and systemic antioxidant properties are advantageous to the antiparasitic properties; ZnO-NPs serve as a good alternative to the old anticoccidials, and in this regard, these properties hold more significance than antiparasitic ones.

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