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Effects of Dietary Levels of Vitamin E on Broiler Breeder Performance

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ABSTRACT

Background. Broiler breeders can directly affect the production of broiler stock, so their performance is critical. Dietary supplements also play a crucial role in improving their performance. The current study aimed to investigate the impact of vitamin E supplements on broiler breeder performance, including egg production, hatching egg fertility, hatchability, and antibody titer against Newcastle disease and avian influenza.

Method. A total of 1500 breeder hens were divided into five groups A, B, C, D, and E. Each group had five (05) replicates. The control group A received no treatment. Group B received 30 mg/kg of vitamin E through feed mixing, Group C received 45 mg/kg; Group D received 60 mg/kg, and Group E received 70 mg/kg of vitamin E through feed mixing. Treatments included two doses of vitamin E (30 and 70 mg/kg) and Zinc-L-selenomethionine and sodium selenite, the two sources of selenium.

Results. The current study showed that egg production was not affected by dietary vitamin E levels or sources of vitamin E ($p > 0.05$). Compared to breeders fed 30mg at 29 weeks, the fertility and hatchability of eggs from breeders fed 70 mg/kg of vitamin E diet was also higher.

Conclusion. The outcome of the current trial demonstrates that dietary supplements consisting of vitamin E (70mg/kg feed) and Zinc-L-selenomethionine may improve egg quality and incubation response.

Keywords: breeder, egg quality, sodium selenite, vitamin E, Zinc-L-selenomethionine

Highlights

- Egg production was not affected adversely when birds were treated with different ratios of vitamin E.

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- Birds treated with vitamin E and Zinc-L-selenomethionine increased the weight of their eggs and albumin.
- Vitamin E (70 mg/kg feed) and Zinc-L-selenomethionine also improved the hatchability of eggs.

1. INTRODUCTION

Pakistan's poultry industry, the second largest in the country, is increasing, with the broiler sector being a favorite due to low start-up costs and quick returns. Pakistan's total meat production was 4.9 million MTs (Metric Tons) in FY21 (Fiscal Year 2021), with a 48% share of beef, 37% poultry, and 15% mutton. The poultry industry's share of Pakistan's GDP (Gross Domestic Product) is 1.3% [1]. Broiler farming needs special attention because it reaches the harvesting age faster than other livestock. However, diseases and lack of quality ingredients hinder broiler performance. New techniques including antibiotics, probiotics, prebiotics, enzymes, and feed additives are currently being explored to boost profit margins. Modern poultry breeds perform better than older ones, although high-quality nutrients are needed for maximum yield [2].

Vitamin E, a naturally occurring antioxidant, can benefit animal health when used in low and high concentrations in diet. Research shows that supplementing the chicken diet with vitamins can increase egg production. Vitamin E can reduce free radicals and affect the immune system through direct and indirect effects on immune cells [3]. Breeder hen production and reproduction improve with vitamin E diet supplementation, while its deficiency can lead to infertile eggs, poor eggshell quality, and decreased immune responses [4]. Various studies have assessed that the presence of vitamin E in the body doesn't negatively affect egg producing chickens physiologically [5].

Alpha-tocopherol content in yolk decreases during embryonic development and remains low in the brain. After 15 days, it increases in the liver, yolk sac membrane, and adipose tissue. NRC recommended adding 4-6 IU VE/kg to the laying chicken hen diet. A previous study found that adding alpha-tocopherol (20 mg/kg) in moderation to male chickens may enhance their immune system's response to SRBC. A lack of vitamin E can weaken immune responses and hinder bursal development in chicks. Elevating dietary alpha-tocopherol in eggs may improve immunity [6]. Vitamin E acts as an anti-stressor. It makes it easier for the liver to release vitellogenin, the forerunner to the yolk, boosting the quantity and quality of eggs laid by laying hens [7].

The current study aimed to determine the optimal dietary vitamin E level and its impact on chicken embryo hatchability. It also investigated the correlation between vitamin E shortage and declining growth and FCR in broiler chickens.

2. MATERIALS AND METHODS

2.1. Experimental Site

The trial began with the approval of the synopsis by the graduate studies and research board at MNS University of Agriculture, Multan, Pakistan. This experimental trial was completed at Star Breeder Farm, Multan. The duration of the trial was four (04) months.

2.2. Experimental Design and Treatment Plan

A total of twelve hundred (1200) hens with 10% male (Cobb 500) were separated randomly at 34 weeks of age and divided into five (05) groups, with five (05) replicates in each group. Hence, each group retained 300 breeding hens; 10% were male. From the age of 35 weeks, the birds' diet was supplemented with vitamin E through drinking water supplied by KBNP. This water is marketed as Toco E Sel (vitamin E a-tocopherol acetate 10%). Vitamin E was used to supplement the diet in both male and female birds. To calculate its dosage, the body weight (BW) of all groups of birds was noted before the start of the trial.

2.3. Feeding and Vaccination

Diets were formulated with corn soya, and vaccines were completed before 20 weeks of age, with titer-based production against ND (Newcastle disease) and IB (infectious bronchitis).

2.4. Data Collection

The current study involved different groups of birds, each receiving varying amounts of vitamin E. Group A did not receive any treatment. Group B received vitamin E at 30mg/kg of BW, group C at 45mg/kg, group D at 60mg/kg, and group E at 70mg/kg. Vitamin E supplementation began at 35 weeks and continued until 42 weeks. Egg collection was started at 37 weeks of age. Eggs were stored at 18°C at 70% relative humidity. They were cleaned and graded, with hatching eggs marked with red, blue, green, and yellow pointers. They were stored for seven days and transferred to an incubator after fumigation and biosecurity parameters. Setters and hatchers were used for 18 days, with hatchability and fertility calculated separately. After 21 days, chicks were counted and sold to the market. Data collection included weekly egg production, hatching, and fertile egg hatching-related parameters. All birds were vaccinated according to the schedule.

2.5. Statistical Analysis

Data was analyzed using SPSS (Version 23.0), and one-way ANOVA was used to examine all the randomized design data statistically.

3. RESULTS

This research aimed to determine the effects of different dietary levels of vitamin E on broiler breeder performance in terms of egg production, fertility, and hatchability. The impact of other groups on egg produced per pen is shown in Table 1. No significant difference was found among all treatment groups ($p > 0.05$). The table shows the numerical mean value of the 60mg/kg group (54.80) as higher, while the control has the minimum value (52.20).

The effect of different groups on fertile eggs is shown in Table 2. No significant difference was found among all treatment groups ($p > 0.05$). The table shows the numerical mean value of the 70mg/kg group (51.60) as higher, while the control has the minimum value (48.40).

Table 1. Effect of Different Groups on Egg Produced per Pen

Treatment	Mean	Std. Deviation	Std. Error	Minimum	Maximum	*p* value
0mg/kg	52.20	3.56	1.59	48.00	56.00	0.676
30mg/kg	53.20	3.27	1.46	48.00	56.00	
45mg/kg	52.40	3.51	1.57	49.00	58.00	
60mg/kg	54.80	3.27	1.46	51.00	58.00	
70mg/kg	54.20	2.77	1.24	52.00	59.00	
Total	53.36	3.17	0.63	48.00	59.00	

Table 2. Effect of Different Groups on Fertile Eggs

Treatment	Mean	Std. Deviation	Std. Error	Minimum	Maximum	*p* value
0mg/kg	48.40	4.04	1.81	44	54	0.436
30mg/kg	49.00	2.74	1.22	45	52	
45mg/kg	50.40	2.97	1.33	47	55	
60mg/kg	51.40	3.78	1.69	46	55	
70mg/kg	51.60	2.07	0.93	49	54	

Table 3. Effect of Different Groups on Fertility Percentage

Treatment	Mean	Std. Deviation	Std. Error	Minimum	Maximum	*p* value
0mg/kg	92.69	3.30	1.48	89.29	98.18	0.11
30mg/kg	92.14	1.31	0.58	90.57	93.75	
45mg/kg	95.23	1.74	0.78	94.34	98.08	
60mg/kg	93.77	3.23	1.44	90.20	98.08	
70mg/kg	95.27	2.84	1.27	91.53	98.15	

The effect of different groups on fertility percentage is shown in Table 3. No significant difference was found among all treatment groups ($p > 0.05$). The table shows the numerical mean value of the 70mg/kg group (95.27) as higher, while the control has the minimum value (92.69).

Table 4. Effect of Different Groups on Eggs Hatched

Treatment	Mean	Std. Deviation	Std. Error	Minimum	Maximum	*p* value
0mg/kg	38.60	4.45	1.99	34	44	0.388
30mg/kg	39.60	1.82	0.81	37	42	
45mg/kg	41.60	3.21	1.44	38	47	
60mg/kg	41.40	3.29	1.47	36	44	
70mg/kg	42.00	2.24	1.00	39	45	

Table 5. Effect of Different Groups on Hatchability Percentage of Fertile Eggs

Treatment	Mean	Std. Deviation	Std. Error	Minimum	Maximum	*p* value
0mg/kg	79.60	3.24	1.45	75.56	83.67	0.548
30mg/kg	80.88	2.25	1.01	76.92	82.35	
45mg/kg	82.48	2.00	0.89	80.00	85.46	
60mg/kg	80.52	1.67	0.75	78.26	82.35	
70mg/kg	81.43	3.76	1.68	75.00	84.00	

The effect of different groups on eggs hatched is shown in Table 4. No significant difference was found among all treatment groups ($p > 0.05$). The table shows the numerical mean value of the 70mg/kg group as higher (42.00), while the control has the minimum value (38.60).

The effect of different groups on the hatchability percentage of total eggs produced is shown in Table 5. No significant difference was found among all treatment groups ($p > 0.05$). The table shows the numerical mean value of the 45mg/kg group (79.37) as higher, while the control has the minimum value (73.80).

4. DISCUSSION

An increased level of vitamin E was provided to breeders. Better nutrient utilization and hatchability may have been made possible by the antioxidant system's potentially increased capability, supported by the more significant content of vitamin E in the diet [8, 9]. It was found that the supply of vitamin E did not influence hatchability. This outcome, however, differs from that of Wang et al. [10], who gave 39-week-old breeders 0.3 mg/kg of vitamin E and saw improvements in terms of progeny performance, lower mortality, and greater hatchability. When Hanafy et al. [11] added 0 to 0.3 mg/kg to the broiler breeder male diet, they saw improvements in semen quality, improving hatchability and fertility.

Polyunsaturated fatty acids (PUFA) are abundant in semen and necessary for preserving sperm membrane characteristics. However, they are easily oxidized [8]. Semen's tocopherol content rises in response to dietary vitamin E supplementation, potentially reducing oxidation susceptibility and boosting fertility [12]. The sperm given organically showed increased motility, which improved fertility [13]. Nonetheless, fertility remained unaffected by the dietary variety of antioxidants examined in this study.

Hatchlings from broiler breeders given diets containing selenium were found to be heavier at 29 ($p = 0.064$) and 33 ($p = 0.031$) weeks, in addition to throughout the experiment ($p = 0.018$; Table 5), when compared to inorganic selenium. The benefits of vitamin E supplementation have been reported in the literature [11, 14], indicating that vitamin E may ultimately replace sodium selenite.

Even though Houssain et al. [15] showed that hatchling weight rose when 100 mg/kg of vitamin E was added to the food, this was not observed in the current investigation. Chick yield, the ratio of hatchling weight to egg weight, measures the embryo's ability to fill the tissue with the nutrients found in the egg [16]. Therefore, it was expected that supplementing broiler breeders' diets with vitamin E would enhance the growth of embryos [17].

High-vitamin E nutritional supplements may be utilized to enhance hatchability and hatchling weight, especially in the case of eggs deposited by young broiler breeders, as well as egg features of older breeders.

Egg production was not impacted by the examined nutritional vitamin E levels or other sources of vitamin E (Table 2). The inclusion of increasing vitamin E levels in the diet has been referred to by many researchers [18–20]. However, Barreto et al. [19] observed no effect in the amount of lay or egg production when vitamin E levels shot up to 25 or 250 mg/kg in the diet of broiler breeders. The impact of supplementing broiler breeders' feed with 25, 50, 75, and 100 mg/kg vitamin E was investigated by Houssain et al. [15]. They researched broiler breeders between the ages of 24 and 54 weeks, or within a comparable timeframe to the current study. They found no differences in the number of eggs produced.

In the current study, vitamin E did not affect egg production; nevertheless, the Brazilian poultry sector widely uses it in its organic form. It has various advantages, including improved changes in egg production [11]. According to Abaza et al.

[21], egg production was enhanced by supplementing the food with Zinc-L-selenomethionine at the maximum rate on lay but not during other lay periods. However, Payne et al. [22] did not observe any significant variations in egg production when they added increasing quantities of organic vitamin E or sodium vitamin E (0, 0.15, 0.30, 0.60, and 3 mg/kg) to layer diets.

It's possible that the Zinc-L-selenomethionine and vitamin E levels administered in this study were insufficient to affect egg production throughout the evaluation period, since an adequate amount of Vitamin E and Zinc-L-selenomethionine is necessary for improvement in growth performance and production [23]. Gao et al. [24] claimed that treating broiler breeders with dexamethasone causes stress in them. When 200 mg/kg of vitamin E was given to them, compared to 20 mg, they saw a spike in egg production. This implies that dexamethasone-induced stress was mitigated by vitamin E administration. Similarly, Kirunda et al. [25] found that adding 60 mg/kg of vitamin E to feed preserved egg production when layers were exposed to thermal stress (an environmental temperature of 34°C) as opposed to chickens kept in thermoneutral conditions (an ecological temperature of 21°C). Moreover, only broiler chicks were used in this study; hence, its findings can't apply to other chicken breeds.

4.1. Conclusion

The current study showed that vitamin E supplementation increased hatching weight up to the peak of egg production (33 weeks) but did not affect hatching quality. The outcome of the current trial demonstrates that dietary supplements consisting of vitamin E (70 mg/kg feed) and Zinc-L-selenomethionine may improve egg fertility and hatchability but did not affect egg production rate. This suggests that adding these supplements to poultry diets may be considered a protective management strategy as they can improve the birds' performance. An adequate dosage of vitamins is recommended for the improvement of the overall growth of the broiler.

CONFLICT OF INTEREST

The author of the manuscript has no financial or non-financial conflict of interest in the subject matter or materials discussed in this manuscript.

DATA AVALIABILITY STATEMENT

The data associated with this study will be provided by the corresponding author upon request.

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