Research Article

Effect of Adding Different Levels of Curcumin Powder to the Diet of Broiler Breeders on Some Productive and Physiological Traits

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Abstract | The period of the experiment was from 1,11, 2023, to 8,2, 2024, for a period of 14 weeks. The study investigated the effect of adding curcumin powder to the diets of broiler breeders on some productive and physiological traits. The study used 72 60-week-old Ross 308 laying hens, broiler breeders. The females were divided into four treatments, with three replicates of each treatment, each containing six females. Each treatment contained eighteen hens. The female groups were fed a basal diet without added curcumin powder. Groups T2, T3, and T4 were fed a diet containing 250, 300, and 350 mg of curcumin powder/kg feed, respectively. To study the productive traits, eggs were collected and weighed daily for each treatment for six periods. Physiological characteristics: The third treatment significantly improved ($p<0.01$) over all other treatments in terms of decreased ALT and AST enzymes. The third treatment also outperformed all other treatments in terms of globulin and total protein. As for production characteristics, the second treatment significantly outperformed the first treatment ($p<0.01$) in terms of shell thickness. The fourth treatment also significantly outperformed all other treatments in terms of relative yolk weight and yolk height.

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Introduction

The increasing world demand for poultry-based protein products firmly underscores the need to continue improving meat and egg productivity. Improving productivity in the poultry industry is directly associated with reproductive performance of broiler breeders (males and females). While males contribute only a fraction of the flock population, their fertility has major impacts on being able to saturing natural and artificial insemination. Flock age, genetic status and feeding system are three interacting factors that have a serious impact on male reproductive performance which is vital for the sustainability of livestock production (Abood and Mousa, 2023; Ali *et al*., 2021).

Over the past years, there has been more interest in using natural bioactive feed additives to replace synthetic growth promoters. Curcumin, a natural bioactive polyphenolic compound extracted from the rhizomes of tumeric (Curcuma longa), is responsible

for turmeric's yellow root inside and has attracted great attention in recent years because of its extensive biological activities. Several reports have shown its antioxidant, anti-inflammatory and antimicrobial activities; which indicate the potential to improve poultry health, immunity effect and disease resistance (Pan *et al*., 2022; Sureshbabu *et al*., 2023).

Curcumin use in diet has shown significant ameliorations in digestibility, physiological status, and reproductive performance of poultry. Its antioxidant and therapeutic effects help to reduce oxidation stress and metabolic syndromes, thereby maintaining reproductive health (Hussein *et al*., 2025). Moreover, the supplement of medicinal plants such as curcumin has been indicated to cure expression of semen quality, testicular histomorphology through increase in seminiferous tubules length, Sertoli cell proliferation and improved spermatogenesis (Abdul Amir *et al*., 2024).

Other studies have also demonstrated that heat stressconi diet with curcumin addition improved egg production performance and elevated chick's body weight at hatch suggesting a higher reproduction efficiency as well as offspring's quality (Wakira *et al*., 2021). Due to its nutritive and therapeutic properties, curcumin has recently become more attractive towards poultry nutritionists as a natural replacement for food chemical additives as it enhances productive performance with economic and health benefits (Plachá *et al*., 2012; Shehata *et al*., 2022; Hamzah and Abdul-Lateef, 2022). In addition, recent studies have shown that curcumin nano-formulation has significantly enhanced the semen quality parameters in broiler breeder males (Ammar *et al*., 2025).

Moreover, there are reports that the use of herbal complexioning agents lead to better reproductive hormone profiles (with particular reference to level of testosterone) and hatchability in broiler breeders (Abdul Amir *et al*., 2024). Elevations in the semen volume, sperm concentration, motility as well as testicular weight and histological characteristics are further reported when herbal additives were added to the drinking water (Ali *et al*., 2022). By the way, there are also reports showing the promotion of egg production traits (yolk pigmentation and egg size) induced by dietary curcumin supplementation (Thuy *et al*., 2022; Abdelkader *et al*., 2024).

Therefore, the present study was conducted to investigate the effects of different dietary levels of curcumin powder on some productive traits in poultry especially reproductive performance.

Materials and Methods

Liver enzyme assessment

At the end of the experiment, on the last day of the experiment, a 5 ml syringe was used, and a needle was inserted into the caudal vein of the females from each replicate. Blood was then drawn into a plastic tube (10 ml gel tube). These plastic tubes were placed in a centrifuge at 6,000 rpm for 15 minutes. They were then transferred to plastic tubes numbered according to each replicate and treatment. They were stored at -20°C and sent to the Ghayat Al-Ma'rifa Laboratory for pathological analysis.

Productive traits measurement

After the first two weeks of the study, eggs were collected daily for each replicate in special containers labeled with the replicate and treatment code. Egg collection took place from 8:00 a.m. to 2:30 p.m. to estimate the average egg weight (g). Eggs were weighed daily for each replicate using a sensitive three-decimal scale (type 1000400-SF). The average egg weight (g) for all replicates of the treatments was calculated weekly.

Following a two-week adaptation period, egg production and egg quality traits were recorded over six consecutive experimental periods, with each period lasting two weeks. Therefore, the total data collection phase extended for 12 weeks, during which eggs were collected daily and measurements were recorded for each replicate within all treatments.

Basal diet and management conditions

The basal diet was formulated to fulfill the nutrient requirement guidelines established for broiler breeders (females) by the National Research Council (NRC). Diet mainly included corn soybean meal, wheat bran, vegetable oil, limestone, dicalcium phosphate, common salt, and vitamin–mineral premix.

Curcumin powder used in the present study was purchased from a commercial source and had not less than 95% purity. The curcumin powder was mixed into the basal diet at 250, 300 and 350 mg/kg feed for T2, T3 and T4 treatments, respectively; whereas the

group of animals in the control (T1) did not receive any addition of curcumin.

Broiler breeder hens were reared under standard management practices for this period of investigation. Birds were housed in environmentally controlled cages under a 16L:8D light schedule. Feed and tap water were offered ad libitum. All of the birds were treated by the uniform hygiene and health management system, and normal vaccination as well as biosecurity procedure were followed throughout the study.

Relative Shell Weight (g)
Use a sensitive balance to the nearest two decimal places.
Calculate the relative shell weight using the following equation:

$$\text{Relative Shell Weight \%} = \frac{\text{Shell Weight}}{\text{Egg Weight}} \text{x } 100$$

Shell thickness
Measure the shell thickness, including the inner membranes, after drying, at the pointed and convex ends of each egg using a micrometer. Average the two readings, according to the equation below, as mentioned by Al-Fayyadh and Naji (1989):

Average Shell Thickness (mm) = Shell Thickness of the First End (mm) + Shell Thickness of the Second End (mm)

Statistical analysis
The experiment was conducted according to a Completely Randomized Design (CRD). Data were analyzed using SPSS software (version 26.0). Differences among treatment means were evaluated using one-way ANOVA, and means were separated using the Least Significant Difference (LSD) test at a probability level of $P \leq 0.05$. Results are presented as mean ± standard error.

Results

We note from Table 1 a significant decrease in the first (control) and fourth treatments compared to the second and third treatments, while there were no significant differences between them in ALT levels. The first treatment also decreased significantly compared to the third treatment, but did not significantly differ from the second and fourth treatments in AST levels. The third treatment significantly outperformed all treatments in total protein levels, while no significant differences were recorded between all treatments in albumin levels. The first and third treatments significantly outperformed the second and fourth treatments in globulin levels, while there were no significant differences between them. We note that there were no significant differences between the treatments in shell weight in the first and second periods and shell thickness in the second period. The second treatment significantly outperformed the first treatment in shell thickness in the first period, while the first, third and fourth treatments did not differ significantly from each other. The fourth treatment significantly outperformed all treatments in relative yolk weight in the first period, while in the second period there were no significant differences between the treatments. The third and fourth treatments significantly outperformed the first and second treatments in yolk height in the first period, while no significant differences were recorded between the treatments in yolk height in the second period.

Table 1: *Adding different levels of curcumin powder to the feed of broiler breeders and its effect on ALT and AST (mean ± standard error).*

Treatments	S.E ± Means	
	ALT	AST
T1	51.10 ± 2.25A	47.98 ± 1.62A
T2	44.71 ± 0.61B	44.06 ± 0.82AB
T3	46.37 ±0.53B	42.57 ±1.14B
T4	47.05 ±1.17AB	45.96 ±1.44AB
4.3463	4.2172	

Table 2: *Adding different levels of curcumin powder to the feed of broiler breeders and its effect on the percentage of albumin, globulin and total protein (mean ± standard error).*

Treatments	S.E ± Means		
	TP	ALB	GLUB
T1	48.46 ± 1.27B	26.37 ± 0.83A	22.08 ± 0.63A
T2	45.89 ± 0.87B	28.12 ± 1.20A	17.76 ± 1.79B
T3	53.38 ±1.29A	26.83 ±0.47A	26.54 ±1.50A
T4	42.17 ±2.16B	26.74 ±0.58A	15.43 ±0.79B
4.8126	2.6958	4.1639	

Discussion

The improvement in these traits, which included

shell weight and thickness, relative yolk weight, yolk height, as well as albumin, globulin, and total protein, may be due to curcumin improving reproductive performance, increasing reproductive hormone levels, encouraging the growth of beneficial organisms, and enhancing the digestion and absorption of nutrients deposited in the egg. This, in turn, results in increased fertility and hatchability, as well as improved embryo development (Ali *et al.*, 2018; Radwan *et al.*, 2008; Wakira *et al.*, 2021). The reason may also be that curcumin powder reduces the effects of oxidative damage such as H2O2, promotes spermatogenesis, and enhances antioxidant activity in the testes by regulating the Nrf2 signaling pathway. This leads to improved fertility and hatchability, reduced embryo mortality, and reduced apoptosis in testicular tissue.

Table 3: *Adding different levels of curcumin powder to the feed of broiler breeders and its effect on shell weight and shell thickness (mean ± standard error).*

Treatments	S.E ± Means			
	Shell weight % first period	Shell weight % second period	shell thickness first period mm	Shell thickness first second mm
T1	11.43 ± 0.37A	12.18 ± 0.72A	0.348 ± 0.01B	0.370 ± 0.004A
T2	11.60 ± 0.32A	11.91 ± 0.21A	0.403 ± 0.01A	0.385 ± 0.01A
T3	11.69 ±0.49A	11.72 ±1.01A	0.385 ±0.02AB	0.396 ±0.01A
T4	11.65 ±0.30A	11.42 ±0.46A	0.400 ±0.005AB	0.396 ±0.01A
1.2441	2.1957	0.0544	0.0367	

Table 4: *Adding different levels of curcumin powder to the feed of broiler breeders and its effect on the relative weight of the yolk and the yolk height % (mean ± standard error).*

Treatments	S.E ± Means			
	Relative weight of yolk % first period	Relative weight of yolk % second period	First period yolk height mm	Second period yolk height mm
T1	32.77 ± 1.58B	30.98 ± 1.14A	3.77 ± 0.12B	4.21 ± 0.33A
T2	33.90 ± 1.04B	32.89 ± 1.81A	3.98 ± 0.11B	5.29 ± 0.82A
T3	31.68 ±1.65B	30.82 ±1.50A	4.77 ±0.22A	5.52 ±0.29A
T4	39.24 ±0.28A	33.53 ±1.87A	4.67 ±0.23A	4.72 ±0.20A
4.1264	5.2502	0.5971	1.5668	

This may be due to the fact that curcumin increased the activity of lipase, maltase, sucrase, trypsin, and chymotrypsin in the digestive tract and pancreatic lipase and improved the levels of microorganisms in the intestine, which led to increased protein digestion and amino acid absorption, as well as activating the liver to increase yolk and nutrients and deposition in the egg, improving the uterine environment, increasing calcium deposition, and increasing the availability of nutrients for laying hens. Mousa *et al.* (2019). The reason may be that curcumin is an active antioxidant, which has led to the activation of intestinal microbes that stimulate the afferent nerves in the intestinal epithelial cells, which directly affects the secretion of gonadal hormones from the hypothalamus and the secretion of the gonadal hormones LH and FSH, which activate the secretion of progesterone, which is directly linked to egg production, i.e., its high level leads to increased egg production, and conversely, its decrease leads to decreased egg production (Brady *et al.*, 2020). Also, intestinal microorganisms can produce short-chain fatty acids from curcumin. These factors are important because they are involved in the composition and maturation of ovarian follicles, which increases the size and number of eggs (Junyan *et al.*, 2024). Al-Jebory *et al.* (2024) Curcumin is considered a hormonal agent, and according to the physiological state of the body, it works as an antioxidant at low doses, and at high doses (it increases autophagy and then the death of harmful cells, so in both cases it achieves a biphasic response on the body's cells (Abbas *et al.*, 2018; Moghaddam *et al.*, 2019). Since medicinal plants contain phenolic compounds (an antioxidant that improves liver function, activates immunity, improves the function of endocrine hormones, increases the level of glutathione peroxidase and catalase, and decreases MDA, thus stimulating the gonads to secrete steroids (estrogen and progesterone) by stimulating the pituitary gland Liu *et al.* (2020) Al-Jebory *et al.* (2024) , Abdul Amir (2024). As Al-Zalzal *et al.* (2024) explained, some medicinal plants have improved the characteristics of semen of broiler breeders. As explained Shakir and Ali (2025) reported that the use of nano-curcumin in feeding broiler breeders improved the semen characteristics, as the ejaculate volume and sperm concentration increased significantly, and the individual and collective sperm motility increased significantly. ALT and AST are most commonly utilized biochemical liver function tests in the poultry. Normal physiological values of ALT and AST activities in broiler breeders have

been shown to be indicative for the hepatic metabolic condition, as values within reference range may not necessarily indicate pathological injury (Radwan *et al*., 2008; Liu *et al*., 2020).

The decrease in activity of ALT and AST found in this experiment, and especially in the groups fed 300 mg curcumin/kg feed could be explained by a better liver function or reduced metabolic stress than an adverse effect. Similar results have been found in other studies, reporting increased antioxidant status, reduction of oxidative stress and stabilization of hepatocellular membranes hence reduced leakage of liver enzymes to blood by dietary curcumin supplementation (Pan *et al*., 2022; Hussein *et al*., 2025).

Accordingly, the reduction of both ALT and AST activities recorded in this study may be an indication that Physalis contain physiologically beneficial factors which are able to promote hepatic health and metabolic efficiency under non-pathological state.

Conclusions and Recommendations

Dietary curcumin powder supplementation altered some physiological and egg quality parameters of broiler breeder hens. Significant normalization in total protein concentration, activities of liver enzymes (ALT and AST), indicating an amelioration in liver function, protein metabolism was found when 300 mg/kg feed supplement was provided (T3).

Regarding egg quality traits, supplementation with 350 mg/kg feed (T4) resulted in significantly higher shell thickness, relative yolk weight and yolk height during the first experimental period. In most periods of evaluation, no significant differences were found among treatments for albumin concentration or shell weight percentage.

These results show that curcumin powder is a potential natural dietary supplement for enhancing some physiological parameters and certain egg quality traits in broiler breeder hens, depending on the level of dietary incorporation.

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Novelty Statement

The originality of the study is, therefore, to have established clear experimental evidences regarding an optimal dietary inclusion level in curcumin powder that had a beneficial impact on physiological parameters and some egg quality traits in elderly cull broiler breeder females. Unlikely earlier reports which mainly studied growth performance or male reproductive parameters, in the present study, the effect of increasing dietary levels of curcumin was studied on liver enzyme activity, protein metabolism,shell traits, and quality yolk under breeder production condition.

Author's Contributions

All authors contributed equally to the design, execution, and writing of this study.

Generative AI and AI-assisted technology statement
The authors declare that no generative AI and AI assisted technology was used in the creation of this manuscript.

Conflict of interest
The authors have declared no conflict of interest.

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