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Research Article
Effect of Turmeric (*Curcuma domestica*, Val) Extract as a Feed Additive on Performance and Egg Quality of Quail

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Abstract

Background and Objective: Turmeric (*Curcuma domestica*, Val) extract (TE) is a natural source of yellow-orange pigment and a natural source of antioxidant, antimicrobial, anti-viral, anti-inflammatory and antitumor compounds. The present study was conducted to evaluate the effect of TE as a feed additive on egg production performances and egg quality of laying quail. **Materials and Methods:** This study used 208 week old Laying quails. The experiment was performed in a completely randomized design (CRD) with five treatments (0, 5, 10, 15 and 20 ppm TE in drinking water) with four replicates each. The basal diet contained 20% crude protein and 2800 kcal kg^{-1}. The parameters measured were feed intake, hen day-egg production, egg weight, egg mass production, feed conversion, egg yolk color and egg cholesterol content. **Results:** Increasing the TE level significantly increased ($p<0.05$) feed intake and hen-day egg production, egg mass production and egg yolk color but significantly decreased ($p<0.05$) feed conversion and egg cholesterol content. Feed intake, hen-day egg production and yolk color were optimal with the inclusion of 20 ppm TE in the drinking water while egg cholesterol content and feed conversion were lowest at this concentration. **Conclusion:** This study shows that 20 ppm TE increased the egg production performance and egg quality of laying quail without notable negative effects and therefore should be considered.

Key words: Egg production performance, egg quality, feed additive, laying hens, turmeric extract

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

The quality of poultry eggs has become an important and decisive part of the successful marketing of livestock products. In particular, physical characteristics that are usually material considerations in choosing a good-quality eggs, include the yellow color of the egg yolk and a large egg size. As public knowledge and awareness of nutrition and health have developed, local communities have become very selective in choosing eggs with certain nutritional qualities such as low in cholesterol and low fat[1].

Quail eggs have advantages compared to other poultry eggs; they are rich in minerals (Ca, Fe, Mg, P, K, Na, Zn, Cu, Mn and Se), vitamins (A, B1, B3, B12 and E) and pantothenic acid[1]. On the other hand quail egg yolks have a higher cholesterol content (as much as 746 mg/100 g)[2] than chicken (352 mg/100 g) and duck (734 mg/100 g) eggs[3]. Currently, small and medium-scale farmers are trying to increase the production of livestock and livestock products by providing feed additive, such as antibiotics. However, antibiotic use in the field, is now being reduced because it can cause side effects that are damaging to the health of consumers in the long term. As an alternative, herbal extracts and plants are now being investigated for use due to their natural antimicrobial properties[1-3]. Of the many herbal plants and extracts that are promising agricultural products for further development, turmeric is commonly cultivated and used in Indonesia[2,3]. According to the Indonesian CBS[4], production of turmeric in Indonesia reaches 112 million t year^{-1}.

The dry matter of turmeric flour is known to contain 9.89% crude protein, 2868 kcal kg^{-1} metabolic energy, 10.79% crude fiber, 1.69% fat, 0.14% calcium, 1.40% phosphorus, 3.18% essential oil and 9.54% curcumin[3]. According to Bernawie[5], turmeric plants have valuable antioxidant, anti-inflammatory, antimicrobial (Gram positive and Gram negative), antiviral and antitumor properties. The key active compounds in turmeric are curcuminoids, which give the rhizome its natural yellow-orange coloration and can help restore peroxide-induced conditions such as liver damage and vascular disease[5]. Curcumin is an orange-yellow crystalline powder that is practically insoluble in water[5].

Based on previous research, utilization of up to 0.6% turmeric has not been shown to affect the blood cholesterol, triglycerides or abdominal fat contents of broiler chickens[6]. Rondonuwu[1] reported that, the addition of 2% turmeric rhizome in quail rations can increase egg yolk color scores from 7-9. The use of turmeric extract (TE) to improve the performance of poultry has been widely practiced. Therefore the purpose of this research was to evaluate TE as a feed additive to improve quail performance and egg quality especially egg cholesterol.

MATERIALS AND METHODS

Birds and experimental diets: This study used 208 week old *Coturnix-coturnix Japonica* quails.

Basal dietary rations: The basal dietary rations were prepared from CP 144 concentrate produced by PT. Charoen Pokphand, corn, rice bran, soybean meal, coconut oil, bone meal, $CaCO_3$ and top mix. The diet was provided ad-libitum.

Turmeric preparation: Turmeric was prepared by drying and grinding turmeric until it became a powder.

Turmeric extract preparation: TE was obtained from by turmeric powder and was extracted using ethanol and water and then dried. Five hundred grams of dried turmeric was first ground in a mixer grinder and then separated with a 40 mesh size. Two grams of the sample was mixed with 30 mL of ethanol at 1.5 h and 30 mL of water at 1 h separated and filtered. The filtrate was taken to a water bath for the ethanol evaporation and petri plates were subsequently transferred into a hot air oven at 130 °C for 1.5 h[7].

Experimental design: The experiment was performed in a completely randomized design using increasing concentrations of TE (0, 5, 10, 15 and 20 ppm) in the drinking water. Each treatment was repeated five times.

Feed formulation: The poultry feed was formulated with 20% CP to provide 2800 kcal kg^{-1} metabolic energy (ME). The nutrients and ME of the formulated feed are shown in Table 1.

Table 1: Nutrient and metabolic energy from the diet formulation used in this study

Ingredients	Formulation (%)
Yellow corn	50.00
Rice bran	8.00
Soybean meal	14.50
Concentrated CP 126	20.00
Bone meal	4.00
$CaCo_3$	3.00
Topmix	0.50
Total	100.00
Nutrient and energy contents	
Crude protein (%)	23.00
Ether extract (%)	3.63
Crude fiber (%)	3.84
Ca (%)	3.73
P (%)	0.84
Lysine (%)	1.15
Methionine (%)	0.56
ME (kcal kg^{-1})	2800.35

Methods: The experiment was performed in a completely randomized design (CRD) with five treatments (0, 5, 10, 15 and 20 ppm TE in drinking water) with four replicates each. There were 10 *Coturnix-coturnix Japonica* laying quails per unit of experiment. The formulation, nutrient content and metabolizable energy content of basal diets are shown in Table 1. The basal diet formulation consists of yellow corn, rice bran, soybean meal, bone meal, CP concentrated 126 (PT Charoen Pokphand), coconut oil, $CaCO_3$ flour and topmix (vitamin and mineral mixed).

Variables: The measured variables were feed consumption (g/head/day), quail-day egg production (%), egg weight (g/ bird), egg mass production (g/head/day), feed conversion, egg yolk color and egg cholesterol (mg/100 g).

Data analysis: All of the data were statistically analyzed by one-way analysis of variance in the completely randomized design (CRD). Significant differences between treatments were determined using Duncan's multiple range test with a $p<0.05$ considered significant.

RESULTS

The effects of treatments on the production performance of laying quails are presented in Table 2.

Feed consumption: The feed consumption of laying quail was affected ($p<0.05$) by the levels of TE present in the diet. Increasing the level of TE increased feed consumption. Feed consumption in the A treatment (control) was 22.13 g/head/day and feed consumption increased in the 20 ppm TE treatment group by 22.98 g/head/day.

Hen-day egg production: The levels of TE in the drinking water influenced ($p<0.05$) the hen-day egg production of laying quails. Increasing TE levels increased hen-day egg production. Hen-day egg production in the control group was 76.33% and egg production increased in the 20 ppm TE treatment group by 79.99%.

Egg weight: The egg weight of laying quail was not significantly affected ($p>0.05$) by supplementation with TE in the drinking water. The egg weight in the control treatment (9.58 g/egg) was similar to that in the 20 ppm TE treatment group (9.73 g/egg).

Egg mass production: The egg mass production of laying quail was affected ($p<0.05$) by the levels of TE in the drinking water. Increasing TE levels increased egg mass production. The egg mass production in the control group was 7.32 g/bird/day and increased to 7.78 g/bird/day in the 20 ppm treatment group.

Feed conversion: The feed conversion ratio of laying quail was affected ($p<0.05$) by the levels of TE in the drinking water. Increasing TE levels decreased feed conversion. The feed conversion in the control was 3.03 and decreased to 2.95 in the 20 ppm group. The effects of TE in the drinking water on the egg quality of laying quail are illustrated in Table 3.

Egg cholesterol: Inclusion of TE in the drinking water of quails significantly decreased ($p<0.05$) the egg cholesterol content in a concentration-dependent manner. Increasing the amount of TE decreased the egg cholesterol content.

Table 2: The effects of turmeric extract as a feed additive on the production performance of laying quail

Treatments	Feed consumption (g/bird/day)	Hen-day production (%)	Egg weight (g/egg)	Egg mass production (g/bird/day)	Feed conversion
A (0 ppm TE)	22.13^{c}	76.33^{b}	9.58	7.32^{b}	3.03^{a}
B (5 ppm TE)	22.45^{c}	77.74^{b}	9.62	7.47^{b}	3.01^{a}
C (10 ppm TE)	22.68^{b}	78.67^{ab}	9.67	7.62^{ab}	2.96^{b}
D (15 ppm TE)	22.93^{a}	79.69^{a}	9.72	7.76^{a}	2.94^{b}
E (20 ppm TE)	22.98^{a}	79.99^{a}	9.73	7.78^{a}	2.95^{b}
SE	0.20	0.50	0.18	0.09	0.17

$^{a-b}$Different superscripts within a column show significance ($p<0.05$), SE: Standard error of the mean

Table 3: The effects of turmeric extract as a feed additive on the egg quality of quail

Treatments	Egg cholesterol (mg/100 g)	Egg yolk color
A (0 ppm TE)	804.32^{a}	8.32^{d}
B (5 ppm TE)	783.74^{b}	8.98^{c}
C (10 ppm TE)	709.20^{c}	9.60^{b}
D (15 ppm TE)	620.02^{d}	10.12^{a}
E (20 ppm TE)	603.23^{e}	10.55^{a}
SE	4.11	0.97

$^{a-d}$Different superscripts within a column show significance ($p<0.05$), SE: Standard error of the mean

The egg cholesterol in the 0 ppm TE treatment group (804.32 mg/100 g) was decreased compared to that in the 20 ppm treatment group (603.23 mg/100 g).

Egg yolk color: The egg yolk color of laying quail was affected ($p<0.05$) by the levels of TE in the drinking water. The egg yolk color in the control was 9.10 and increased to 11.76 in the 20 ppm treatment group.

DISCUSSION

Feed consumption, hen-day production and egg mass increased when TE was added to the drinking water of laying quail (8-12 weeks of age) in this study, with the highest consumption achieved when 20 ppm TE was added. High feed intake was caused by the effect of the high curcumin (10.02% found in turmeric) content. Increased curcumin content results in increased palatability and increased feed consumption. According to Aviati[8] curcumin increased appetite by regulating gastric acid secretion, regulating HCl secretion and regulating pepsin enzymes, increasing the efficiency of the enzymes and enhancing food digestion.

The feed consumption range observed in this study with the addition of the TE additive (22.13 - 22.98 g/head/day) was also similar to the results of a study by Costa *et al.*[9] who found that the feed consumption of laying quail (6-13 weeks of age) supplemented with prebiotic and organic minerals ranged from 21.23-22.03 g/head/day. This result was higher than those presented by Nataliyus *et al.*[10] who found that the feed consumption of *Coturnix coturnix Japonica* quail (7-12 weeks of age) ranged from 20.99-21.07 g/head/day when diet supplemented with *Leuchaena leuchocepala* leaf.

The hen-day egg production of quail in this study was the highest for birds supplemented with 20 ppm TE, which was likely due to the concomitant increase in feed consumption. High feed intake of laying quail increases nutrient consumption, particularly protein intake and can increase egg production[11]. Findings of the present study (HDEP 76.33-79.99%) were similar to those of Tuleun *et al.*[12], who showed that hen-day egg production of laying quail ranged from 78.00- 81.67% as well as those of Nuraini *et al.*[2], who found that the HDEP of laying quail (8-12 weeks of age) ranged from 74.33-80.69% when diet supplemented with turmeric extract.

The average egg weights observed in this study were similar to those observed by Tuleun *et al.*[12], who found that the average egg weight of laying quail fed a diet consisting of 20% crude protein was 9.75 g/egg. This result is also similar to the results obtained by Al-Daradji *et al.*[13] who showed that laying quail supplemented with up to 6% linseed in the diet produced an average egg weight ranging from 9.40-11.13 g/egg as well as the results obtained by Vali *et al.*[11], who showed that the average egg weight for 8-12-week-old laying quail ranged from 8.90-9.56 g/egg.

The present study showed that egg mass was influenced by TE in the diet, which was a result of the increase in egg production and egg weight. Nuraini *et al.*[2] showed that the egg mass of laying quail ranged from 7.12-7.89 g/bird/day when quail fed marigold extract. Costa *et al.*[9] also found that the egg mass of laying quail ranged from 7.32-7.76 g/bird/day when they were fed prebiotic and organic minerals, which was similar to the findings of the current study.

The lowest feed conversion ratio observed in this study, which is defined as the ratio between feed intake and egg production[2,8], occurred with 20 ppm TE supplementation in the diet. Feed conversion can be used as a surrogate marker of the egg production coefficient, whereby a smaller value indicates a more efficient use of feed to produce an egg[2]. The average feed conversion ratio observed in this study was higher than that obtained by Nataliyus *et al.*[10], which ranged from 2.17-2.20 when quail were fed diets containing *leucaena leu chocepala* leaf. Results of the current study were also slightly higher than those presented by Costa *et al.*[9] (range: 2.50-2.70) and Nuraini *et al.*[2] (range: 2.79-2.90).

The lowest egg cholesterol level was observed with 20 ppm TE supplementation, which is likely associated with the increased curcumin content. Curcuminoid are the primary matter in turmeric and are responsible for the turmeric"s yellow dye. Curcumin can help repair peroxide-induced bodily conditions such as liver damage and vascular disease. Curcumin can reduce egg cholesterol by increasing bile secretion, pancreatic fluid and cholesterol excretion through the feces[5]. Extensive investigation over the last five decades has indicated that curcumin reduces blood cholesterol[14]. Curcumin has a significant hypocholesteremic effect in hypercholesteremic rats. Curcumin significantly reduces low density lipoprotein and very low density lipoprotein in plasma and total cholesterol levels in liver[14]. Our results indicated that 20 ppm TE decreased egg cholesterol levels by 25.00%.

It is also observed that TE supplementation of 20 ppm resulted in a darker egg yolk color (redness). The highest egg yolk color was found with 20 ppm TE supplementation (which is accumulated with increasing curcumin levels in the drinking water). Rondonuwu[1] reported that the addition of 2% turmeric rhizome in quail rations can increase egg yolk color scores from 7-9.

CONCLUSION

Increasing the TE content in the drinking water of laying quail can improve the performance and egg quality. Providing TE supplementation up to 200 ppm resulted in an increase in hen-day egg production and a decrease in the feed conversion ratio. In addition, the egg cholesterol level was reduced by 25.00%.

SIGNIFICANCE STATEMENT

This study discovered that turmeric extract in drinking water can improve the performance and egg quality of quail by increasing egg yolk color and decreasing egg cholesterol levels. This study will help the researchers uncover the critical positive effects of the curcumin found in turmeric on improving performance and egg quality that has not been explored by researchers. Thus, a new theory on the curcumin found in turmeric may be developed.

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