Research in
AGRICULTURE, LIVESTOCK and FISHERIES
ISSN : P-2409-0603, E-2409-9325
An Open Access Peer-Reviewed International Journal

Article Code: 460/2024/RALF
Article Type: Research Article

Res. Agric. Livest. Fish.
Vol. 11, No. 3, December 2024: 305-314.

Effects of Supplementation of Cinnamon and Turmeric Powder on Performance and Quality of Quail Eggs

Mofassara Akter[1*], Md. Asaduzzaman[2], Md. Saiful Islam[3], Md. Ashik Iqbal[1], and Md. Imran Hossain[1]

[1]Department of Animal Nutrition, Genetics and Breeding, Faculty of Animal Science and Veterinary Medicine, Sher-e-Bangla Agricultural University, Dhaka-1207; [2]Department of Dairy Science, Faculty of Animal Science and Veterinary Medicine, Sher-e-Bangla Agricultural University, Dhaka-1207; [3]Department of Animal Production and Management, Faculty of Animal Science and Veterinary Medicine, Sher-e-Bangla Agricultural University, Dhaka-1207.

***Corresponding author:** Mofassara Akter; E-mail: makter.angb@sau.edu.bd

ARTICLE INFO

Received
20 October, 2024

Revised
12 November, 2024

Accepted
28 December, 2024

Key words:
Cinnamon
Turmeric
Performance
Egg quality
Japanese quail

ABSTRACT

The experiment was conducted to investigate the effect of mixed supplementation of turmeric and cinnamon powder on the performance and egg quality of Japanese quail. This study entailed of five treatments with four replications of 20 quails each established in a completely randomized design. The treatments consisted of T_0 (control), T_1 (10 g cinnamon + 10 g turmeric)/kg of feed, T_2 (10 g cinnamon + 20 g turmeric)/kg of feed, T_3 (20 g cinnamon + 10 g turmeric)/kg of feed, and T_4 (20g cinnamon + 20g turmeric)/kg of feed. Feed intake, body weight, feed conversion ratio, egg production, yolk weight, white weight, shell weight, yolk color index, and cholesterol level were among the parameters that were examined. In addition, the percentages of quails that reached maturity at 42 days of age were recorded. The obtained results indicated that supplementing the diet with a mixture of turmeric and cinnamon reduced feed intake and significantly ($P<0.05$) improved the feed conversion ratio. The average body weight of quails at 42 days did not differ significantly ($P>0.05$) among the various treatment groups. The dietary supplementation of turmeric and cinnamon, significantly increased the egg production percentage, egg yolk weight and significantly ($P<0.05$) decreased egg yolk cholesterol level. Therefore, it is recommended that incorporating 20g of turmeric and 20g of cinnamon powder per kg of feed can enhance the performance and egg quality of Japanese quails.

To cite this article: Akter M., M. Asaduzzaman, M. S. Islam, M. A. Iqbal, and M. I. Hossain, 2024. Effects of supplementation of cinnamon and turmeric powder on performance and quality of quail eggs. Res. Agric. Livest. Fish. 11(3): 305-314.

DOI: https://doi.org/10.3329/ralf.v11i3.78722

Introduction

Nowadays, one of the most prominent operations in the poultry industry is quail farming. It is a simple activity that, in comparison to other farming operations, demands a cheap initial investment in facilities. The rising demand for quail eggs and meat is encouraging farmers to begin or expand their quail production. This activity is significant in the industrial poultry sector since it is developing quickly and offers investors encouraging outcomes. Poultry eggs' quality is becoming a key factor in animal goods' effective marketing. Specifically, physical attributes such as the large size and yellow yolk are typically important factors when selecting a high-quality egg. According to Rondonuwu et al. (2014), local communities have become increasingly picky about the eggs they choose, especially those that are low in fat and cholesterol, as public education and understanding of nutrition and health have grown.

Quail eggs are superior to other poultry eggs because they are high in pantothenic acid, vitamins A, B_1, B_3, B_{12}, and E, and minerals (Ca, Fe, Mg, P, K, Na, Zn, Cu, Mn, and Se) (Rondonuwu et al., 2014). However, compared to chicken eggs (352 mg/100 g) and duck eggs (734 mg/100 g), quail egg yolks contain up to 746 mg/100 g of cholesterol. Small and medium-sized farmers are currently attempting to improve cattle and animal product productivity by adding feed additives like antibiotics. Nonetheless, the use of antibiotics in the field is currently being curtailed due to the potential for long-term adverse consequences that could harm consumers' health. The natural antibacterial qualities of plants and herbal extracts are currently being researched for usage as an alternative (Rondonuwu et al., 2014, Nuraini et al. 2017). Because herbal components have biological activity, they can be employed to enhance poultry performance (Sharifi et al., 2013). Herbal substances such extracts of Artemisia, thyme, oregano, and rosemary can be added to broiler chickens to improve feed digestibility and growth performance (Nosrati et al., 2017). In addition to lowering cholesterol and triglyceride levels, herbal compounds in broiler chickens enhance antibody titers against viral infections, including Newcastle disease (Jouybari et al., 2009; Houshmand et al., 2012). Turmeric and cinnamon are two of the many herbal plants and extracts that show promise as agricultural goods for future growth and use in Bangladesh.

Cinnamomum zeylanicum (Cinnamon) is one of the oldest natural remedies, dating back 4,000 years. These days, cinnamon and its mixture with other herbs are added to chicken feed. According to Tung et al. (2008) and Chou et al. (2013), cinnamon includes active chemicals called cinnamon aldehyde and eugenol, which have antiseptic, antioxidant, antibacterial, and cholesterol-lowering properties. Supplementing broiler chickens with cinnamon improves their development performance, pancreatic lipase activity, and feed intake (Vali and Mottaghi, 2016; Kim et al., 2010). Additionally, this chemical enhances chicken feed intake (Isabel and Santos, 2009) and meat quality (Sang-oh et al., 2013). Cinnamon includes proxeronine, which the body transforms into xeronine, which enhances intestinal protein absorption and stimulates growth-related enzymes (Şimşek et al., 2015). Egg production, quality, and hatchability can all be improved by adding cinnamon to the quail diet. According to Vali et al. (2013), adding cinnamon and thyme to quail feed can enhance egg quality without changing the weight of the yolk.

The turmeric plant (*Curcuma longa*) yields the rhizome known as turmeric. According to Abdullah et al. (2010), turmeric is a member of the Zingiberacae family, which is abundant in phenolic compounds that have anti-mutagenic and anti-carcinogenic qualities. Curcumin, desmethoxycurcumin, bisdemethoxycurcumin, and tetra-hydro curcuminoid (Kiuch et al., 1993) are among the active chemicals found in turmeric that have nematocidal, anti-inflammatory, and antioxidant properties (Kiuch et al., 1993; Osawa et al., 1995). Additionally, turmeric powder includes phytoestrogens that promote ovarian follicle development (Saraswati et al., 2014); as a result, adding turmeric powder to a diet increases egg weight and production (Gumus et al., 2018).

Turmeric supplements can increase pancreatic lipase and digestive enzymes (Platel and Srinivasan, 2000). Curcumin at a level of 0.2 g/kg has been shown to improve the digestive process and upsurge nutrient utilization by increasing the length and weight of the duodenum, jejunum, and caeca in broiler diets (Rajput et al., 2013). According to Arafa (2005), curcumin prevents the digestive tract from absorbing dietary cholesterol. In addition to lowering LDL and raising HDL in quail eggs, curcumin has been shown to lower triglyceride and cholesterol levels in quail blood (Saraswati et al., 2013, 2014; Saraswati and Tana, 2016). There is currently little information available in Bangladesh regarding the quail's growth performance and egg quality. We hypothesized that adding a mixture of cinnamon and turmeric powder to quail rations would enhance quail development and egg quality while reducing cholesterol in quail eggs in Bangladesh. Based on the aforementioned justifications, the purpose of this study was to ascertain how the performance and egg quality of Japanese quail were affected by a combination of cinnamon and turmeric powder supplementation.

Materials and Method

Placement of the experiment

The research was conducted at Sher-e-Bangla Agricultural University Poultry Farm, Dhaka, Bangladesh, using 400 three-week-old Japanese quails (*Coturnix japonica*) with an average body weight of 68.00±30 g. The birds were collected from Rajbari Quail Hatchery, Pangsha, Rajbari.

Experimental design

Four hundred three-week-old quails were divided into five treatments, with four replicates per treatment (Table 1). Each replicate contained 20 quails, following a completely randomized design. The treatments comprised a mixture of turmeric and cinnamon powder (TCP) and included the following groups: T_0 (control); T_1 (10 g turmeric + 10 g cinnamon) / kg of feed; T_2 (10 g cinnamon + 20 g turmeric) / kg of feed; T_3 (20 g cinnamon + 10 g turmeric) / kg of feed and T_4 (20 g cinnamon + 20 g turmeric) / kg of feed.

Table 1. Layout of the experiment

Treatments	Distribution of treatments	Replications				Total number of birds
		1	2	3	4	
T_0	Basal feed	20 birds	20 birds	20 birds	20 birds	80
T_1	Basal feed + (10 g cinnamon +10 g turmeric)/ Kg feed	20 birds	20 birds	20 birds	20 birds	80
T_2	Basal feed + (10 g cinnamon + 20 g turmeric)/ Kg feed	20 birds	20 birds	20 birds	20 birds	80
T_3	Basal feed + (20 g cinnamon + 10 g turmeric)/ Kg feed	20 birds	20 birds	20 birds	20 birds	80
T_4	Basal feed + (20 g cinnamon + 20 g turmeric)/ Kg feed	20 birds	20 birds	20 birds	20 birds	80
Grand Total		**100**	**100**	**100**	**100**	**400**

Collection and preparation of TCP

Fresh turmeric root was collected from the local market, then peeled and cut into thin slices (about 2 mm thick). The slices were kept in an oven at a low temperature (60°C) for 2 days. Once completely dry, the turmeric was ground into a fine powder and sifted through a sieve (0.5 mm diameter) to achieve a consistent texture. Cinnamon bark was collected from the local market, cut into small pieces (1.5-2.5 cm), dried in an oven at 60°C for 2 days, then ground using a spice grinder and sifted through a sieve (0.5 mm diameter) to achieve a uniform powder.

Preparation of experimental house

The poultry farm was designed as a south-facing, open sided natural house featuring a durable concrete floor. The experimental shed was thoroughly cleaned and washed with tap water to ensure a hygienic environment. Additionally, all equipment within the shed was properly cleaned and disinfected to eliminate any potential contaminants. Measures were taken to protect the birds from predators such as dogs, cats, rodents, and hunting birds. Flies and insects were effectively controlled by spraying lysol and phenol around the surroundings of the poultry farm. Additionally, the shed was well-ventilated to ensure proper airflow and maintain a healthy environment for the quails.

Management of quail

The various aspects of quail management, along with the experimental events and management practices are described in detail below:

Receiving and distribution of quail birds

Immediately after the birds arrived at the experimental house, their initial weight was recorded using a digital electronic balance, and they were distributed into the different blocks of the cage. The birds were provided with glucose water containing vitamin C to drink for the first three hours in order to alleviate dehydration and transportation stress.

Room temperature and relative humidity

Daily room temperature and relative humidity were recorded with a thermometer and a wet and dry bulb hygrometer respectively. The average room temperature ranged from 20.40°C to 36.85°C, while the relative humidity varied between 27.00% and 82.05%.

Feeding and drinking

Three-week-old quails were adapted to a commercial feed for 28 days, and the experimental diets were offered starting at 29 days of age. Commercial poultry starter and layer feed were offered per week in different formations with a 2% calcium supplement in laying period. Feed and *ad libitum* drinking water were provided to the quails. The chemical composition and nutritional content of the experimental diets are detailed in Table 2 and Table 3.

Lighting

Quails are highly sensitive to light, so a lighting plan of 17 hours per day was implemented, comprising 12 hours of natural daylight and an additional 5 hours of artificial light. During the rearing, development, and pre-laying phases, the birds were exposed to natural light. To meet the luminance requirement for laying Japanese quails (20 lx) as specified by Murakami and Ariki (1998), lights were strategically positioned in front of the cages. Light-emitting diode (LED) lights were used to provide consistent illumination at night.

Beak trimming and post-trimming managements

Beak trimming was performed on the quails at 7 weeks of age using a heated blade. To minimize stress, bleeding, weight loss, and dehydration before and after beak trimming, several precautions were taken. The birds were kept in a comfortable environment with an adequate amount of fresh, cool water at all times, and beak trimming was done in the morning. After beak trimming, the birds were treated with vitamin K and vitamin C to minimize bleeding.

Table 2. Nutritional composition of starter and layer ration

Parameters	Starter Ration	Layer Ration
Energy (ME/Kcal)	3100±50	2900±50
Moisture (%)	12.00	12.00
Crude protein (%)	22.5±1	17±1
Crude fat (%)	5.50	4.0
Crude ash (%)	6.0	13.50
Crude Fiber (%)	4.0	4.0
Lysine (%)	1.35	0.87
Methionine (%)	0.55	0.42
Calcium (%)	1.0	3.80
Phosphorus (%)	0.50	0.42

Table 3. Percentage of weekly supplied ration for quail

Week	Ration Type	
	Starter Ration	Layer ration
1st	100	-
2nd	100	-
3rd	100	-
4th	78	22
5th	90	10
6th	90	10
7th	90	10
8th	90	10

Recorded parameters

Throughout the study, data on weekly live weight, feed consumption and egg production were systematically recorded. FCR was calculated from the total feed consumption, the number of eggs, and the weight of eggs in each replication. Following egg collection, measurements were taken for egg weight, eggshell weight, egg yolk weight, egg white weight, yolk color index, and cholesterol levels from each replication. Egg quality assessments were conducted at the end of the 6th and 10th weeks by randomly selecting three eggs from each replication. These measurements included weighing the eggs using a digital scale and evaluating yolk color with a Roche egg yolk color fan for accurate comparison. Egg samples were collected at the end of the experiment and egg yolk cholesterol level determined by laboratory test.

Statistical analysis

The collected data were analyzed statistically using one-way ANOVA with the Statistical Package for Social Sciences (IBM SPSS Statistics 26.0.1.0), following the principles of a completely randomized design (CRD). Mean differences were assessed using Duncan's multiple comparison test, with significance determined at $P<0.05$.

Results and Discussion

The current study's findings have been examined and reviewed in order to determine how cinnamon and turmeric powder affect the quality and performance of quail eggs.

Production performance of Japanese quail

Feed intake

The feed intake (g/bird/day) of quail birds at different treatment are presented in Table 4. The feed intake of quail birds in different treatment T_0, T_1, T_2, T_3 and T_4 were 21.33 ±0.05, 21.25±0.01, 21.16±0.07, 21.01±0.01 and 21.19±.06 respectively (Table 4). Feed intake of T_3 was significantly ($P<0.05$) lower than other treatments including control. Increased supplementation of turmeric and cinnamon led to decreased feed intake because of changes in the feed's flavour, palatability, and taste. According to Riasi (2012), adding turmeric to the diet at concentrations of 0.15 and 0.20% decreased feed intake. Quail feed intake was unaffected by cinnamon supplementation at a level of 12.0 g/kg of food, though, because feed consumption is based on energy and protein levels (Santos, 2019). The present study revealed that addition of 20 g cinnamon and 20 g turmeric in quail ration reduces the feed intake of quails.

Table 4. Effects of cinnamon and turmeric powder on production performance of Japanese quail

Treatments	Feed intake (g/bird/day)	Body weight at 42 days of age (g/bird)	FCR	Laying quail Percentage at 42 days	Egg production (%)
	Mean±SE	Mean±SE	Mean±SE	Mean±SE	Mean±SE
T_0	21.33^{a} ±0.05	169.00±3.05	3.77^{ab}±0.10	30.55^{ab}±2.77	62.03^{ab}±1.49
T_1	21.25^{ab}±0.01	169.66±0.88	3.65^{ab}±0.26	32.93^{b}±1.72	64.88^{ab}±4.69
T_2	21.16^{b}±0.07	167.66±1.76	3.85^{a}±0.08	29.76^{ab}±1.19	59.99^{b}±2.35
T_3	21.01^{c}±0.01	167.00±1.52	4.15^{a}±0.06	25.00^{a}±1.37	57.28^{b}±0.87
T_4	21.19^{b}±0.06	172.33±0.88	3.31^{b}±0.19	33.33^{b}±1.81	70.57^{a}±3.88
Level of significance	*	NS	*	*	*

Here, T_0= Control (Basal feed), T_1 = Basal feed + (10g turmeric+10gcinnamon)/kg feed, T_2 = Basal feed + (20g turmeric+10g cinnamon)/kg feed, T_3= Basal feed + (10g turmeric+20g cinnamon)/kg feed, T_4= Basal feed + (20g turmeric+20g cinnamon)/kg feed. Values are mean ± SE (n=80) one-way ANOVA (SPSS, Duncan method). * Significant difference ($P<0.05$). NS: Non-significant. SE= Standard Error. ^{abc}: Values bearing different letters within each column.

Body weight at 42 days of age

Body weight at 42 days of age (g) of quail birds at different treatment presented in Table 4. The body weight at 42 days of age (g) of quail birds in different treatment T_0, T_1, T_2, T_3 and T_4 were 169±3.05, 169.66±0.88, 167.66±1.76, 167±1.52 and 172.33±0.88 respectively. The treatments did not differ significantly ($P<0.05$). Despite lowering feed consumption, supplementing with cinnamon and turmeric had no effect on body weight. According to this research, cinnamon and turmeric can increase growth and feed utilization efficiency. Turmeric improves nutrient absorption in birds by increasing the excretion of digestive enzymes, pancreatic lipase, and intestinal villi size (Rajput et al., 2013). It was discovered that adding 5.0 g/kg of feed containing a mixture of cumin and turmeric can raise body weight (AL-Kassie, 2011).

Percentage of laying quail at 42 days

Percentage of laying quail at 42 days of quail birds at different treatment presented in Table 4. The percentage of laying quail at 42 days of quail birds in different treatment T_0, T_1, T_2, T_3 and T_4 were 30.55±2.77, 32.93±1.72, 29.76±1.19, 25.00±1.37, 33.33±1.81 respectively (Table 4.). Compared to other treatments, including control, the percentage of laying quail at 42 days of T_4 was considerably ($P<0.05$) greater. Phytoestrogens found in cinnamon and turmeric have an impact on poultry reproduction. Moreover, phytoestrogens cause hepatocytes to produce more vitellogenin, which increases the amount of vitellogenin deposited in the yolk of the egg (Levi, 2009). According to Şimşek (2015), cinnamon supplements can raise blood serum zinc levels because zinc possesses a potent antioxidant that prevents membrane cell oxidative damage. Furthermore, Saraswati (2013) found that quails on a diet devoid of supplements containing turmeric powder experienced delayed reproductive maturity and began laying at 45 days of age. The present study revealed that addition of 20g turmeric and 20g cinnamon per kg quail diet shows the highest laying percentage at 42 days of quail.

Egg production percentage of quail

The egg production percentage of quail birds at different treatment presented in Table 4. The egg production percentage of quail birds in different treatments T_0, T_1, T_2, T_3 and T_4 were 62.03±1.49, 64.88±4.69, 59.99±2.35, 57.28±0.87 and 70.57±3.88 respectively (Table 4). Compared to the other treatments, including control, the quail birds in T_4 produced a considerably higher percentage of eggs ($P<0.05$). Vitellogenin increases follicle formation by travelling to the ovaries through the circulation (Elnagar and Abd-Elhady, 2009). According to Şimşek et al. (2015), the usage of cinnamon and thyme can lengthen the intestine and enhance the width and depth of villi. This will improve nutrient absorption and, eventually, improvement the production and quality of eggs. The present study revealed that the addition of 20g turmeric and 20g cinnamon in per kg ration of quail shows the highest egg production in quail.

Feed Conversion Ratio (FCR)

The feed conversion ratio is presented in Table 4. The final feed conversion ratio of quail birds in different treatments T_0, T_1, T_2, T_3 and T_4 were 3.77±0.10, 3.65±0.26, 3.85±0.08, 4.15 ±0.06 and 3.31±0.19 respectively (Table 4). The final feed conversion ratio of quail birds of T_4 was significantly ($P<0.05$) better than the other treatments with control. Due to the beneficial effects of turmeric and cinnamon on enhancing intestinal absorption, their supplementation greatly increased the feed conversion ratio. The use of 2.0% turmeric powder instead of 4.0% produced lighter-colored yolks and a greater FCR. In contrast to the control diet, however, the application of 4.0% turmeric led to a decrease in egg weight (Ali, 2007). According to Riasi et al. (2012), laying hens (100–104 weeks old) who received 0.2% turmeric powder had considerably higher egg weights and better FCR. According to Durrani (2006), the FCR significantly improved when turmeric (5 g/kg of diet) was added to the diet. The present study revealed that the addition of 20g turmeric and 20g cinnamon in per Kg ration of quail shows the better FCR in quail.

Egg quality of Japanese quail

The effects of adding different amounts of cinnamon and turmeric to eggs on their cholesterol levels and quality are shown in Table 5. The average egg weight of quail birds in different treatments T_0, T_1, T_2, T_3, and T_4 were 10.59±0.38, 10.41±0.04, 10.69±0.10, 10.78±0.13 and 10.73±0.18 respectively. The differences between the treatments were not statistically significant ($P<0.05$). The average eggshell weight of quail birds in different treatments T_0, T_1, T_2, T_3, and T_4 were 1.32±0.08, 1.36±0.03, 1.43±0.02, 1.35±0.01 and 1.42±0.05 respectively. The treatments did not differ significantly ($P<0.05$). The average egg white weight of quail birds in different treatments T_0, T_1, T_2, T_3, and T_4 were 5.68±0.13, 5.84±0.10, 5.85±0.05, 5.71±0.07 and 5.52±0.19 respectively. None of the treatments differed significantly ($P<0.05$). The average yolk weight of quail birds in different

treatments T_0, T_1, T_2, T_3, and T_4 were 3.43±0.15, 2.96±0.06, 3.33±0.16, 3.38±0.10 and 3.49±0.14 respectively. The average yolk weight of T_4 (3.49±0.14) was significantly (P<0.05) better than the other treatments including the control. The average egg color index of quail birds in different treatments T_0, T_1, T_2, T_3, and T_4 were 4.67±0.19, 4.45±0.22, 4.67±0.19, 4.78±0.11 and 4.44±0.29 respectively. No significant change (P<0.05) was seen between the treatments. The yolk cholesterol levels of quail birds in different treatments T_0, T_1, T_2, T_3, and T_4 were 467±1.15, 389±0.58, 422±0.58, 342±1.15 and 396±0.58 respectively. The yolk cholesterol level of T_3 was significantly (P<0.05) better than the other treatments including the control. Diets supplemented with cinnamon and turmeric showed an improvement in the cholesterol level of eggs. This result is explained by turmeric's ability to enhance nutritional absorption (Saraswati and Tana, 2016). Curcumin is an antiatherogenic substance that lowers blood cholesterol levels and the quantity of cholesterol transferred to the yolk by preventing the absorption of cholesterol in the feed (Emadi and Kermanshahi, 2006). These findings are consistent with earlier study (Arafa, 2005).

Table 5. Effects of cinnamon and turmeric on egg quality of Japanese quail

Treatments	Egg weight (g/egg)	Eggshell weight (g/egg)	Egg white weight (g/egg)	Egg yolk weight (g/egg)	Egg color index	Egg yolk cholesterol (mg/100 g)
	Mean±SE	Mean±SE	Mean±SE	Mean±SE	Mean±SE	Mean±SE
T_0	10.59±0.38	1.32±0.08	5.68±0.13	3.43^{a}±0.15	4.67±0.19	467^{a}±1.15
T_1	10.41±0.04	1.36±0.03	5.84±0.10	2.96^{b}±0.06	4.45±0.22	389^{c}±0.58
T_2	10.69±0.10	1.43±0.02	5.85±0.05	3.33^{ab}±0.16	4.67±0.19	422^{b}±0.58
T_3	10.78±0.13	1.35±0.01	5.71±0.07	3.38^{a}±0.10	4.78±0.11	342^{d}±1.15
T_4	10.73±0.18	1.42±0.05	5.52±0.19	3.49^{a}±0.14	4.44±0.29	396^{c}±0.58
Level of significance	NS	NS	NS	*	NS	*

Here, T_0= Control (Basal feed), T_1 = Basal feed + (10g turmeric+10gcinnamon)/kg feed, T_2 = Basal feed + (20g turmeric+10g cinnamon)/kg feed, T_3= Basal feed + (10g turmeric+20g cinnamon)/kg feed, T_4= Basal feed + (20g turmeric+20g cinnamon)/kg feed. Values are mean ± SE (n=80) one-way ANOVA (SPSS, Duncan method). * Significant difference (P<0.05). NS: Non-significant. SE= Standard Error. ^{abcd}: Values bearing different letters within each column.

Conclusion

The research work was conducted to investigate whether the supplementation of turmeric and cinnamon mixture in quail rations could improve growth performance, egg production, and the egg quality of Japanese quail. The results found that the body weight at 42 days of age, egg weight, eggshell weight, egg white weight, and egg yolk color index of quail birds were non-significant (P<0.05) among the treatment groups. However, the addition of 20g cinnamon and 20g turmeric per kg ration showed significant improvement in FCR and egg production. Moreover, the addition of 20g cinnamon and 20g turmeric per kg ration significantly reduced levels of cholesterol in quail egg yolks and increased the egg yolk. Therefore, the experiment recommended that turmeric powder and cinnamon powder at the concentration level of 20g turmeric powder and 20g cinnamon powder per kg feed could be used on quail ration for better performances and better quality of quail egg.

Acknowledgements

The authors express their gratitude to the Sher-e-Bangla Agricultural University Research System (SAURES) for providing financial support for this research project.

Conflict of Interest

The authors stated that there are no conflicting interests.

References

1. Abdullah S, Abidin SAZ, Murad NA, Makpol S, Ngah WZW and Yusof YAM, 2010. Ginger extract (*Zingiber officinale*) triggers apoptosis and G0/G1 cells arrest in HCT 116 and HT 29 colon cancer cell lines. African Journal of Biochemistry Research, 4(5): 134-142.
2. Ali MN, Hassan MS and El-Ghany FA, 2007. Effect of strain, type of natural antioxidant and sulphate ion on productive, physiological and hatching performance of native laying hens. International Journal of Poultry Science, 539-554.
3. AL-Kassie GA, Mohseen AM and Abd-AL-Jaleel RA, 2011. Modification of productive performance and physiological aspects of broilers on the addition of a mixture of cumin and turmeric to the diet. Research Opinions in Animal and Veterinary Sciences, 31-34.
4. Arafa HM, 2005. Curcumin attenuates diet-induced hypercholesterolemia in rats. Medical Science Monitor, 228-234.
5. Chou ST, Chang WL, Chang CT, Hsu SL, Lin YC and Shih Y, 2013. Cinnamomum cassia essential oil inhibits α-MSH-induced melanin production and oxidative stress in murine B16 melanoma cells. International Journal of Molecular Sciences, 14(9): 19186-19201.
6. Durrani FR, Ismail M, Sultan A, Suhail SM, Chand N and Durrani Z, 2006. Effect of different levels of feed added turmeric (*Curcuma longa*) on the performance of broiler chicks. Journal of Agricultural Biological Sciences, 9-11.
7. Elnagar SA and Abd-Elhady AM, 2009. Exogenous estradiol: productive and reproductive performance and physiological profile of Japanese quail hens. International Journal of Poultry Science, 8(7): 634-641.
8. Emadi M and Kermanshahi H, 2006. Effect of turmeric rhizome powder on performance and carcass characteristics of broiler chickens. International Journal of Poultry Science, 5:1069-1072.
9. Gumus H, Oguz MN, Bugdayci KE and Oguz FK, 2018. Effects of sumac and turmeric as feed additives on performance, egg quality traits, and blood parameters of laying hens. Revista Brasileira de Zootecnia, 47.
10. Houshmand M, Azhar K, Zulkifli I, Bejo MH and Kamyab A, 2012. Effects of non-antibiotic feed additives on performance, immunity and intestinal morphology of broilers fed different levels of protein. South African Journal of Animal Science, 42(1): 23-32.
11. Isabel B and Santos Y, 2009. Effects of dietary organic acids and essential oils on growth performance and carcass characteristics of broiler chickens. Journal of Applied Poultry Research. 18(3): 472–476.
12. Jouybari MG, Pour VR, Nagharchi MMZ, Taghizadeh MR and Dehpanah N, 2009. The effect of novel probiotic on blood parameters and performance in broiler chickens. Journal of Cell and Animal Biology, 3(8): 141-144.
13. Kim DK, Lillehoj HS, Lee SH, Jang SI and Bravo D, 2010. High-throughput gene expression analysis of intestinal intraepithelial lymphocytes after oral feeding of carvacrol, cinnamaldehyde, or Capsicum oleoresin. Poultry Science, 89(1): 68-81.
14. Kiuch F, Goto Y, Sugimoto N, Tsuda Y, Akao N and Kondo K, 1993. Nematocidal activity of turmeric: synergistic action of curcuminoids. Chemical and Pharmaceutical Bulletin, 41(9): 1640–1643.
15. Levi L, Pekarski I, Gutman E, Fortina P, Hyslop T, Biran J, Levavi-Sivan B and Lubzens E, 2009. Revealing genes associated with vitellogenesis in the liver of the zebrafish (*Danio rerio*) by transcriptome profiling. BMC genomics, 141.
16. Murakami A and Ariki J, 1998. Produção de codornas japonesas. Jaboticabal: FUNEP;79p

17. Nosrati M, Javandel F, Camacho LM, Khusro A, Cipriano M, Seidavi A and Salem AZM, 2017. The effects of antibiotic, probiotic, organic acid, vitamin C, and Echinacea purpurea extract on performance, carcass characteristics, blood chemistry, microbiota, and immunity of broiler chickens. Journal of Applied Poultry Research, 26(2): 295-306.
18. Nuraini, Mirzah and Djulardi A, 2017. Carotenoid extract from yellow flower and tuber in the diet to produce meat and egg low of cholesterol. Kompetensi Dikti Research Report, University of Andalas, West Sumatra, Indonesia.
19. Osawa T, Sugiyama Y, Inayoshi M and Kawakishi S, 1995. Antioxidative activity of tetra hydro curcuminoids. Bioscience, Biotechnology, and Biochemistry, 59(9): 1609-1612.
20. Platel KK and Srinivasan, 2000. Influence of dietary spices and their active principles on pancreatic digestive enzymes in albino rats. Food/Nahrung, 42-46.
21. Rajput N, Muhammad N, Yan R, Zhong X and Wang T, 2013. Effect of dietary supplementation of curcumin on growth performance, intestinal morphology and nutrients utilization of broiler chicks.The Journal of Poultry Science, 50(1): 44-52.
22. Riasi A, Kermanshahi H and Mahdavi AH, 2012. Production performance, egg quality and some serum metabolites of older commercial laying hens fed different levels of turmeric rhizome (*Curcuma longa*) powder. Journal of Medicinal Plant Research, 2141-2145.
23. Rondonuwu C, Saerang JLP, Nangoy FJ and Laataung S, 2014. Addition of turmeric rhizome (Curcuma domestica, val.), Temulawak (Curcuma xanthorrhiza Roxb.) and white gathering (Curcuma zedoaria Rosc.) In commercial ration of quail egg quality (Coturnix-coturnix Japonica). Journal of Zootek, 34: 103-113.
24. Sang-Oh P, Chae-Min R, Byung-Sung P and Jong H, 2013. The meat quality and growth performance in broiler chickens fed diet with cinnamon powder. Journal of Environmental Biology, 34(1): 127.
25. Santos TS, Lopes CDC, Junior O, Murilo G, Santos LM, Santana CCS and Souza DM, 2019. The use of cinnamon powder in the diet of Japanese laying quail. Acta Scientianum Animal Sciences, 1-7.
26. Saraswati TR, Manalu W, Ekastuti DR and Kusumorini N, 2013. The role of turmeric powder in lipid metabolism and its effect on quality of the first quail's egg. Journal of the Indonesian Tropical Agriculture, 123-130.
27. Saraswati TR, Manalu W, Ekastuti DR and Kusumorini N, 2014. Effect of turmeric powder to estriol and progesterone hormone profile of laying hens during one cycle of ovulation. International Journal of Poultry Science, 13(9): 504-509.
28. Saraswati S and Tana TR, 2016. Effect of turmeric powder supplementation to the age of sexual maturity, physical, and chemical quality of the first Japanese Quail's (*Coturnix japonica*) egg. Biosaintifika . Journal of Biology and Biology Education, 18-24.
29. Sharifi SD, Khorsandi SH, Khadem AA, Salehi A and Moslehi H, 2013. The effect of four medicinal plants on the performance, blood biochemical traits and ileal microflora of broiler chicks. Veterinarski arhiv, 83(1): 69-80.
30. Şimşek ÜG, Ciftci M, Özçelik M, Azman MA, Tonbak F and Özhan N, 2015. Effects of cinnamon and rosemary oils on egg production, egg quality, hatchability traits and blood serum mineral contents in laying quails (*Coturnix coturnix* Japonica). Ankara University Vet. Fak Derg, 229-236.
31. Tung YT, Chua MT, Wang SY and Chang ST, 2008. Anti-inflammation activities of essential oil and its constituents from indigenous cinnamon (*Cinnamomum osmophloeum*) twigs. Bioresource Technology, 99(9): 3908-3913.
32. Vali N and Mottaghi S, 2016. The effect of using different levels of cinnamon and thyme powder on egg characteristics and fatty acids profile in Japanesese quail. CIB Tech Journal of Zoology, 5(3): 2319-3883.
33. Vali N, Shahin H and Vatankhah M, 2013. Determination of the effects of Cinnamomum zeylanicum Blume and Thymus vulgaris on performance and egg quality of Japanese quail (*Coturnix japonica*). Research Opinions in Animal and Veterinary Sciences, 3(9): 280-284.