Asian-Aust. J. Anim. Sci.
Vol. 20, No. 6 : 944 - 947
June 2007

www.ajas.info

The Effects of Dietary Garlic Powder on the Performance, Egg Traits and Blood Serum Cholesterol of Laying Quails

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ABSTRACT : This study was conducted to study the effects of dietary garlic powder on laying performance, egg traits and blood serum cholesterol level of quails. A total of three hundred quails (*Coturnix coturnix japonica*) aged nine weeks were used. They were allocated to 3 dietary treatments. Each treatment comprised 5 replicates of 20 quails. The diets were supplemented with 0, 5 and 10 g/kg garlic powder. The experimental period lasted 21 weeks. The addition of garlic powder did not significantly affect body weight, egg production, feed consumption, feed efficiency, egg shell thickness, egg albumen index, egg yolk index and egg Haugh unit. Adding 5 and 10 g/kg garlic powder to the laying quail diets increased egg weight ($p<0.01$). Egg yolk cholesterol and blood serum cholesterol concentration were reduced with garlic powder supplementation. The results of this study demonstrated that garlic powder addition had a significant cholesterol-reducing effect in serum and egg yolk without adverse effects on performance and egg traits of laying quails.
(**Key Words** : Garlic Powder, Quail, Laying Performance, Egg Traits, Serum Cholesterol)

INTRODUCTION

Garlic has potential hypolipidemic, hypotensive, hypoglycemic, hypothrombotic and hypoatherogenic properties (Bordia et al., 1975; Shoetan et al., 1984; Warshafsky et al., 1993; Silagy and Neil, 1994). In addition, two components of garlic, S-allylcysteine sulfoxide (alliin) (Itokawa et al., 1973) and diallyl disulfide-oxide (allicin) (Augusti and Mathew, 1974) were shown to lower cholesterol levels of rats (Itokawa et al., 1973; Augusti and Mathew, 1974).

Previous studies with laying hens and broilers showed controversial results about the hypocholesterolemic effect of garlic (Qureshi et al., 1983; Reddy et al., 1991; Konjufca et al., 1997; Birrenkott et al., 2000; Chowdhury et al., 2002; Yalçın et al., 2006). Reddy et al. (1991) reported that the values of body weight, egg production, egg weight, feed efficiency, yolk cholesterol and plasma cholesterol of laying hens were not affected by the supplementation of diets with 0.2 g/kg garlic oil. In the study of Chowdhury et al. (2002), no differences in egg weight, egg mass, feed consumption, feed efficiency and body weight gain among the groups fed diets containing different levels of sun-dried garlic paste (0, 20, 40, 60, 80 or 100 g/kg) were found but serum and egg yolk cholesterol concentrations have been shown to decrease linearly ($p<0.05$) with increasing levels of dietary garlic. The reduction of the activities of hepatic 3-hydroxy-3-methylglutaryl-CoA (HMG-CoA) reductase and cholesterol 7α-hydroxylase in the birds fed garlic was observed by some researchers (Qureshi et al., 1983; Konjufca et al., 1997). In the study of Yalçın et al. (2006), garlic powder addition at the level of 5 and 10 g/kg increased egg weight ($p<0.01$) and decreased egg yolk cholesterol concentration as mg/g yolk ($p<0.01$) and serum triglyceride ($p<0.05$) and cholesterol ($p<0.01$) concentrations without adverse effects on performance and egg traits of laying hens. However, Birrenkott et al. (2000) reported that 30 g/kg garlic powder supplementation had no significant effect on yolk and serum cholesterol concentrations of hens and they also observed no differences in color and flavor in eggs from hens consuming up to 30 g/kg dietary garlic powder.

There are no published reports about the dietary garlic powder for laying quails as we know. Therefore, the present study was aimed to examine the effects of garlic powder on laying performance, egg traits and blood serum cholesterol

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Received October 11, 2006; Accepted January 18, 2007

Table 1. Ingredient and chemical composition of the diets (g/kg)

Ingredients	Garlic powder (g/kg)		
	0	5	10
Corn	590.0	585.0	580.0
Soya bean meal	162.5	162.5	162.5
Fullfat soya	120.0	120.0	120.0
Fish meal	40.0	40.0	40.0
Limestone	73.5	73.5	73.5
Dicalcium phosphate	7.5	7.5	7.5
Salt	2.5	2.5	2.5
Vitamin-mineral premix[a]	2.5	2.5	2.5
DL-Methionine	1.0	1.0	1.0
Lysine	0.5	0.5	0.5
Garlic powder	0.0	5.0	10.0
Chemical composition (Analyzed, per kg)			
Metabolizable energy[b] (MJ)	12.53	12.59	12.41
Dry matter (g)	922.5	934.7	906.4
Crude protein (g)	194.5	199.7	199.4
Ether extract (g)	48.2	41.2	42.3
Crude fibre (g)	26.8	25.4	27.5
Crude ash (g)	98.9	100.7	97.8
Calcium (g)	30.5	31.0	29.5
Total phosphorus (g)	6.3	6.2	7.0

[a] Composition (per 2.5 kg): 12.000.000 IU Vit A, 2,400.000 IU Vit D_3, 30 g Vit E, 2.5 g Vit K_3, 2.5 g Vit B_1, 6 g Vit B_2, 4 g Vit B_6, 20 mg Vit B_{12}, 25 g niacin, 8 g Calcium D-pantothenate, 1 g folic acid, 50 g Vit C, 50 mg D-biotin, 150 g Choline chloride, 1.5 g Canthaxanthin, 0.5 g Apocarotenoic acid ester, 80 g Mn, 60 g Zn, 60 g Fe, 5 g Cu, 1 g I, 0.5 g Co, 0.15 g Se.

[b] Metabolizable energy content of diets was estimated according to Leeson and Summers (2001).

level of laying quails.

MATERIALS AND METHODS

Animals and diets

A total of 300 Japanese quails (*Coturnix coturnix japonica*) aged nine weeks were chosen at random from a large flock. They were housed in cages (20 cm×45 cm×45 cm) and randomly allocated to 3 dietary treatments. Each treatment comprised 5 replicates of 20 quails. Therefore, 3 groups containing 100 quails each were arranged. Feed and water were provided for *ad libitum* consumption and the diets were presented in mash form. A photoperiod of 17 h was maintained. The experiment was conducted for 21 weeks.

The ingredient and chemical composition of the diets were given in Table 1. The diets were formulated to be isocaloric and isonitrogenous. The diets of the first, second and third groups were supplemented with 0, 5 and 10 g/kg garlic powder, respectively. Garlic powder was purchased commercially (Arifoğlu Spices and Food Limited Inc., İstanbul, Turkey).

Traits measured

Moisture, crude ash, crude fibre, ether extract, crude protein, calcium and total phosphorus contents of diet were determined according to the AOAC (1990). Metabolizable energy levels of diets were estimated using a prediction equation (Leeson and Summers, 2001):

$$\begin{aligned} \text{ME (kcal/kg)} = 53 + 38\ &((\text{crude protein, \%}) \\ &+ (2.25 \times \text{ether extract, \%}) \\ &+ (1.1 \times \text{starch, \%}) + (\text{sugar, \%})) \end{aligned}$$

Quails were weighed individually at the beginning and at the end of the experiment. Eggs were collected daily and egg production was calculated as a bird-day basis. Mortality was recorded as it occured.

Eggs were weighed every week individually for one day of production. Feed consumption was recorded biweekly and calculated as g/quail/day. The value of feed efficiency was calculated as kg feed per kg egg and kg feed per one dosen egg.

To determine the egg traits, 15 eggs were collected from each group (3 eggs from each replicate) at the 3rd, 9th, 15th and 21st week of the experiment. Individual eggs were weighed and their shell thickness was measured. Then the values of yolk height, albumen height, yolk width, albumen width and albumen length were determined. By using these values, yolk index, albumen index and Haugh unit were calculated (Card and Nesheim, 1972). Egg quality analyses were completed within 24 h of the eggs being collected. At the end of the experiment, 35 eggs per group (7 eggs from each replicate) were randomly chosen to determine yolk cholesterol. Eggs were boiled for 5 minutes. Cholesterol was extracted according to the method of the AOAC (1990).

Blood samples from 15 quails were collected randomly from each group (3 from each replicate) at the slaughtering time at the end of the experiment and centrifuged at 3.000× g for 10 min. Serum was collected and stored at -20°C for determination of serum cholesterol level. Serum was analysed for cholesterol by Hitachi autoanalyser (Serial Number 1238-23, Hitachi Ltd, Tokyo) using commercial kit.

Statistical analyses

Statistical analyses were done using SPSS programme (SPSS Inc., Chicago, IL, USA). One way ANOVA was used to evaluate the effects of garlic powder on performance, egg traits and blood serum cholesterol level of laying quails among groups. The significance of mean differences between groups was tested by Duncan. The effect of supplementation on the mortality of laying quails was evaluated by the x^2 test (Dawson and Trapp, 2001).

RESULTS AND DISCUSSION

During the experimental period, 10 (10%), 15 (15%) and 13 (13%) quails died in the groups fed diets

Table 2. The effects of garlic powder on performance of laying quails (mean±standard error)

	Garlic powder (g/kg)		
	0	5	10
Body weight at start (g)	223.3±2.0	220.3±1.9	222.9±2.1
Body weight at end (g)	232.3±3.0	230.1±2.5	232.6±2.5
Feed consumption (g/quail d)	34.5±0.68	34.7±0.29	34.6±0.58
Egg production (eggs/quail d)	0.804±0.021	0.804±0.027	0.792±0.020
Egg weight (g)	12.01±0.03[b]	12.19±0.03[a]	12.13±0.03[a]
Feed efficiency (kg feed/one dosen egg)	0.51±0.01	0.52±0.02	0.52±0.01
Feed efficiency (kg feed/kg egg)	3.58±0.09	3.56±0.15	3.62±0.08

[a,b] Mean values in the same row having different superscripts are significantly different ($p<0.01$).

Table 3. The effects of garlic powder on egg traits and blood serum cholesterol of laying quails (mean±standard error)

	Garlic powder (g/kg)		
	0	5	10
Egg shell thickness (μm)	244.1±2.0	246.2±1.7	245.7±2.3
Egg albumen index	7.71±0.20	7.13±0.24	7.32±0.21
Egg yolk index	45.2±0.49	45.2±0.53	46.0±0.44
Egg Haugh unit	79.4±0.48	77.6±0.60	78.2±0.53
Egg cholesterol (mg/g yolk)	19.09±0.83[a]	16.00±0.83[b]	16.59±0.59[b]
Blood serum cholesterol (mg/dl)	188.47±8.91[a]	155.80±15.26[b]	160.73±25.20[b]

[a,b] Mean values in the same row having different superscripts are significantly different ($p<0.01$).

supplemented with 0, 5 and 10 g/kg garlic powder, respectively. Mortality was not affected by the inclusion of garlic powder. Similar to the result of the present study, garlic powder supplementation had no effect on mortality in laying hens (Yalçın et al., 2006).

The effects of garlic powder on performance of laying quails are shown in Table 2. Body weight, feed consumption, egg production and feed efficiency were not significantly affected by dietary treatments over the 21 weeks period. These results demonstrate that the strong odor of garlic does not act as a deterrent to feeding. In agreement with the present study, some researchers (Reddy et al., 1991; Chowdhury et al., 2002; Yalçın et al., 2006) reported that body weight, body weight gain, feed consumption, egg production and feed efficiency of laying hens were not significantly affected by dietary garlic supplementation.

Egg weight increased with garlic powder ($p<0.01$). Similar results were also reported by Yalçın et al. (2006). However some researchers (Reddy et al., 1991; Chowdhury et al., 2002; Lim et al., 2006) found that garlic products had no effect on egg weight. These differences may be due to the use of different commercial garlic products and the preparation methods of garlic powder.

The effects of garlic powder on egg traits and blood serum cholesterol of laying quails are shown in Table 3. The addition of garlic powder had no significant effect ($p>0.05$) on the egg shell thickness, egg albumen index, egg yolk index and egg Haugh unit. These results are in agreement with the results of study involving laying hen fed diets supplemented with garlic powder (Yalçın et al., 2006). Lim et al. (2006) also reported that egg shell thickness was not affected by the dietary supplementation of garlic powder.

Adding 5 and 10 g/kg garlic powder to the laying quail diets reduced egg yolk cholesterol and blood serum cholesterol concentration significantly ($p<0.01$) as shown in Table 3. The reduction of serum and egg yolk cholesterol when garlic paste was fed to the laying hens could be attributable to the reduction of synthetic enzyme activity (Chowdhury et al., 2002). Konjufca et al. (1997) reported that the reduction in the activities of HMG-CoA reductase and cholesterol 7α-hydroxylase in broilers fed garlic. The results of the present study are in agreement with some studies (Sharma et al., 1979; Chowdhury et al., 2002; Mottaghitalab and Taraz, 2004). Sharma et al. (1979) observed that egg yolk cholesterol was reduced by 4.1 and 5.5% when laying hens were fed 10 and 30 g/kg garlic powder for 3 weeks, respectively. Supplementation of 20, 40, 60, 80 or 100 g/kg of sun dried garlic paste (Chowdhury et al., 2002), 5, 10 or 15 g/kg of garlic powder (Mottaghitalab and Taraz, 2004) and 30 g/kg garlic powder (Lim et al., 2006) reduced serum and egg yolk cholesterol concentration. Similar to the present study, Yalçın et al. (2006) also reported that the levels of serum cholesterol in laying hens were significantly ($p<0.01$) reduced with 5 and 10 g/kg garlic powder supplementation. However, Reddy et al. (1991) found that 0.2 g/kg garlic oil in the diets of laying hens did not significantly reduce total plasma cholesterol. These inconsistent findings may be due to the differences in supplemental levels, feeding period or preparation method of garlic products (e.g. organic solution extraction, alcohol extraction, simple drying, and etc.) (Lim et al., 2006).

It is concluded that garlic powder can be included in diets for laying quails at the levels of 5 or 10 g/kg without

any adverse effect on the performance and egg traits. The main important result of dietary garlic powder supplementation is the significant cholesterol-reducing effect in both serum and egg yolk in laying quails. Further studies should be necessary to evaluate the effects of garlic powder on egg yolk composition and its cholesterol-depressing mechanism of action.

ACKNOWLEDGEMENT

This study was supported by Ankara University Research Fund (Project No. 99-10-00-002).

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