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Effects of Dietary Garlic on Performance and Serum and Egg Yolk Cholesterol Concentration in Laying Hens

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Abstract: This study was conducted to evaluate the potential for local dietary garlic to influence egg yolk and blood cholesterol concentrations and overall performance in commercial layers. Forty 30-week-old white leghorn layers (ten hens per diet) were caged individually and fed diets supplemented with 0 (control), 2, 6 and 8% oven dried garlic powder (at low temperature i.e., 55°C) for 6 week. There were significantly differences ($p<0.01$) among diets in weight gain and egg production as averaged over 6 week. However, no differences ($p>0.05$) were observed among diets in feed consumption, feed efficiency, egg weight and egg mass with increasing levels of dietary garlic. Serum and egg yolk cholesterol concentrations decreased ($p<0.01$) with increasing levels of dietary garlic. It was concluded that dried garlic powder in the diets of commercial laying hens reduced serum and yolk cholesterol concentrations. It was also concluded that dietary garlic powder had better effects on layer performance.

Key words: Oven dried garlic powder, cholesterol, yolk, serum, performance

INTRODUCTION

Garlic (*Allium sativum*) is widely distributed and used in all parts of the world. Several clinical reports, including meta-analyses, have described the hypocholesterolemic effect of garlic in humen (Warshafsky *et al*., 1993; Silagy and Neil, 1994).

Animal studies suggest that garlic has potential hypolipidemic, hypoglycemic, hypotensive and hypothrombotic properties (Bordia *et al*., 1975; Shoetan *et al*., 1984). Many studies indicated that allicin was the potentially active component of garlic which inhibits the growth of pathogenic bacteria (Samanta and Dey, 1991). Allicin is sulphur containing compound (thio-2-propene-1-sulfinic acid S-allyl ester) and its production from an odorless precursor alliin, is catalyzed by an enzyme, alliinase or alliin lyase and responsible for the characteristic smell of garlic (Yeh and Liu, 2001). Egg yolk cholesterol was reduced by the feeding of 1 or 3% garlic powder to laying hens for 3 week (Sharma *et al*., 1979). Sklan *et al*. (1992) reported decreased hepatic cholesterol concentration in chicken when 2% garlic was fed for 14 days. However, Birrenkott *et al*. (2000) reported that 3% garlic powder, did not have any significant effect on yolk and serum cholesterol concentrations when laying hens were fed diets for 8 months.

Reddy *et al*. (1991) reported that egg production; egg mass, body weight, feed intake and feed efficiency were not affected during the 8 week when 0.02% garlic oil was fed to the Babcock B-300 strain. Egg yolk cholesterol concentrations have been shown to vary depending on the genetic strain of the laying hens (Han and Lee, 1992).

Some studies, however, suggested that commercial garlic oil, garlic powder and commercially available garlic extract may not be hypocholesterolemic (Isaacsohn *et al*., 1998; McCrindle *et al*., 1998). Although the reason for this is unknown, it likely relates to low level of garlic, preparation methods,

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the stability of chemical components and the duration of the study (Amagase *et al*., 2001). The present study was conducted; therefore, characterize the hypocholesterolemic effects of high levels of local available oven-dried garlic powder in the diets of white leghorn laying hens.

MATERIALS AND METHODS

Experimental Birds and Diets

This experiment was conducted in experimental sheds of Breeding and Incubation Section, Poultry Research Institute, Rawalpindi in the months of April-May, 2006. Forty, 30-week-old hens of commercial white leghorn strain (ten birds per diet) were used in this study. Hens were caged individually and provided with 16 h of light daily. All birds were fed isonitrogenous and isocaloric mash diets for 6 week. The diets were formulated to meet or exceed the nutrient requirements of laying hens (National Research Council, 1994). Diets were supplemented with 0 (control), 2, 6 and 8% oven dried garlic in powder form. The composition of the experimental diets is shown in Table 1. The nutrients composition of dietary powder garlic is given in Table 2. Feed and water were provided *ad libitum*.

Table 1: Composition of experimental diets

	Garlic powder in diet (%)			
Nutrients	0	2	6	8
Maize	48.00	48.00	48.00	48.00
Rice broken	10.42	10.42	10.42	10.42
Rice polishing	5.58	5.58	5.58	5.58
Wheat bran	1.50	1.50	1.50	1.50
Canola meal	7.00	7.00	7.00	7.00
Rape seed meal	3.00	3.00	3.00	3.00
Guar meal	3.35	3.35	3.35	3.35
Sunflower meal	3.00	3.00	3.00	3.00
Soyabean meal	3.37	3.37	3.37	3.37
Fish meal	3.00	3.00	3.00	3.00
Garlic powder	0.00	2.00	6.00	8.00
Molasses	3.00	3.00	3.00	3.00
Bone meal	1.50	1.50	1.50	1.50
Marble chips	6.66	6.66	6.66	6.66
Salt	0.06	0.06	0.06	0.06
L-Lysine	0.12	0.12	0.12	0.12
DL-Methionine	0.09	0.09	0.09	0.09
Pre-mix	0.30	0.30	0.30	0.30
Choline chloride	0.05	0.05	0.05	0.05

Table 2: Nutrient composition of experimental diets

	Garlic powder in diets (%)			
Nutrients	0	2	6	8
M Kcal kg^{-1}	2740	2799	2804	2813
CP (%)	15.80	15.78	15.64	15.49
C. Fat (%)	3.55	3.80	4.00	4.15
C. Fibre (%)	4.78	4.60	4.60	4.50
T. Ash (%)	9.38	9.35	9.30	9.30
Calcium (%)	3.00	3.10	3.15	3.20
Phosphorus (Available) (%)	0.36	0.35	0.30	0.30
Lysine (%)	0.82	0.81	0.80	0.80
Methionine (%)	0.39	0.39	0.38	0.37
Methioni cystene (%)	0.63	0.63	0.62	0.62
Sodium (%)	0.18	0.18	0.18	0.18
NaCl (%)	0.38	0.38	0.35	0.35
Lino (%)	1.35	1.35	1.31	1.30
Cholesterol concentration	0.016	0.017	0.017	0.017

Source and Preparation Methods for Diets

Locally produced garlic bulbs were purchased from market. The garlic was harvested in April-May. The age of the bulbs, when dried, was 2 to 4 months. Fresh garlic bulbs were cut into pieces with husk. Then it was subsequently thinly spread on a hot air oven tray at 55°C. Drying process was continued for 20-24 h to ensure the appropriate consistency for the grinding to make a powder form. Diets were prepared the following day and were stored at room temperature for a maximum of 6 week.

Experimental Parameters Studied

Birds were randomly assigned to diets and fed daily. Body weight measured weekly and body weight gain was recorded. Weekly feed consumption was recorded and feed efficiency was calculated during the 6 week experimental period. Daily egg production was recorded and egg weights were determined weekly. Egg mass was calculated on the basis of egg production and egg weight (egg production × egg weight/100). Eggs were collected weekly from each bird for cholesterol analysis beginning at the 21 day of feeding.

Blood was also collected from each bird weekly beginning at the 21 day of feeding from the wing vein using sterilized syringes and needles. Serum was isolated 4 to 6 h after blood collection. Serum samples were maintained at -5°C for upto 2 day until cholesterol analysis. For extraction of yolk and diet lipids, one gram of yolk was placed into a centrifuge tube. Fifteen milliliters of chloroform:methanol (2:1 v/v) was added, blended on a vortex mixture and allowed to extract for 12 h. Diet lipid was also extracted by the same method using a 5 g sample with 40 mL of chloroform:methanol.

Serum, extracted yolk and diet samples were analyzed for cholesterol according to the colorimetric method of Abell *et al*. (1952). Diets and garlic powder were analyzed for dry matter, crude protein, crude fat and crude fibre according to the Association of Official analytical Chemist (1980).

Statistical Analysis

Data were statistically analyzed by using Completely Randomized Design. Duncan's Multiple Range tests were used to compare the treatment means (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

It was observed that cholesterol concentrations in all diets were low and similar to those found in the control diet (Table 1). The garlic powder contained 13.12% crude protein, 2.0% ether extract, 35.5% crude fibre and 2.5% total ash on dry matter basis. The first 2 week that garlic was added as a supplement to the diet allowed the birds to be acclimatized with the experimental diet.

Layer Performance

The birds fed diets containing garlic powder gained more weight ($p<0.01$) than those of birds fed diets without garlic (Table 3). Similar trend was observed in feed consumption and egg production. However, feed efficiency, egg weight and egg mass were not affected significantly by diet as averaged over the 6 week period (Table 3). In agreement with the current study, Samanta and Dey (1991) reported that Japanese quails gained more weight and egg production ($p<0.05$) without affect on feed consumption and its efficiency with garlic powder. They explained that such improvement might be due to allicin, an active component, present in garlic powder which inhibits the growth of pathogenic bacteria and aflatoxin producing fungi. In contrast to the above study, Reddy *et al*. (1991) reported that body weight gain and egg production in Babcock layer with 0.02% garlic oil was not affected during the 8 week. The reason of this difference might be due to use of low level of garlic concentration and garlic oil.

Table 3: Effects of dietary garlic on performance of commercial laying hen

Items	A	B	C	D
Weight gain (g week^{-1})	75.00^{d}	95.00^{c}	117.00^{b}	130.00^{a}
Egg production (%)	75.00^{b}	78.00^{a}	78.80^{a}	80.00^{a}
Egg weight (g)	55.35	56.25	56.33	56.38
Egg mass (g day^{-1} hen^{-1})	41.51	43.07	44.22	45.10
Feed consumption (g day^{-1} hen^{-1})	112.00^{d}	117.00^{c}	120.00^{b}	125.00^{a}
Feed efficiency (feed intake:egg mass) (g:g)	2.700	2.716	2.714	2.772

$^{a-d}$Means with the different superscript within rows are significantly different ($p<0.01$). A: 0% garlic; B: 2% garlic; C: 6% garlic; D: 8% garlic

Table 4: Effects of dietary garlic on serum cholesterol concentrations in commercial laying hens (mg 100 mL^{-1})

Diets	Week 3	Week 4	Week 5	Week 6
0% garlic powder	165^{a}	169^{a}	170^{a}	169^{a}
2% garlic powder	141^{b}	138^{b}	137^{b}	136^{b}
6% garlic powder	117^{c}	117^{c}	113^{c}	112^{c}
8% garlic powder	102^{d}	96^{d}	96^{d}	90^{d}

$^{a-d}$Means with the different superscript within column are significantly different ($p<0.01$). [1]Data are reported at least square means n = 6

The present results are also in accordance with the findings of Ashfaq (2001), who reported that supplementation of garlic powder had non-significant ($p>0.05$) effect on egg weight in commercial layers. However, El-Habbak (1988) reported that egg weight in commercial layers increased with supplementation of ethanol extracted garlic because of egg laying rate was decreased. In our study, egg laying rate was increased with supplementation of garlic powder.

Blood Serum Cholesterol

Serum cholesterol concentrations decreased ($p<0.01$) with increasing levels of garlic powder in weeks 3, 4, 5 and 6 (Table 4). In this study, 2, 6 and 8% garlic powder reduced serum cholesterol concentrations on average over 6 week by 19.52, 33.72 and 46.74%, respectively as compared with the control diet. Plasma cholesterol was reduced by 30% when rats were fed diets supplemented with 2 or 3% garlic powder (Myung *et al*., 1982). Qureshi *et al*. (1983a) reported that diets equivalent to 1, 2, 4, 6 and 8% garlic paste reduced serum cholesterol by 18, 21, 21, 24 and 25%, respectively, in male broiler chickens. Similarly, in another study, Qureshi *et al*. (1983b) also reported that serum cholesterol concentration in White Leghorn pullets was reduced from 20-25% with supplementations of garlic paste, a solvent extracted garlic paste and commercial garlic oil. They explained that such reduction in cholesterol concentration with supplementation of garlic might be due to the inhibition of fatty acid synthesis; organic tellurium compounds and allicin found in garlic might contribute to lower serum cholesterol by inhibiting squalene epoxidase which needed in the synthetic pathway of cholesterol. The cholesterol concentrations in laying hens fed the control diet in the present study were comparable as reported by McNaughton (1978), who observed 165 mg/100 mL plasma cholesterol in White Leghorn hens when fed similar levels of crude fiber as the current study.

Egg Yolk Cholesterol

Cholesterol concentrations per gram of yolk decreased ($p<0.01$) with increasing levels of garlic powder (Table 5). Dietary garlic at 2, 6 and 8% reduced egg yolk cholesterol, on average over 6 week, by 5.7, 14.28 and 23.57%, respectively as compared with control diet. The results of the present study are in line of the findings of Sharma *et al*. (1979) reported that egg yolk cholesterol was reduced by 4.1 or 5.5% when laying hens were fed 1 or 3% garlic powder for 3 week. Similarly, egg yolk cholesterol was decreased 7.28 and 6.83% by feeding diets containing 5 and 10% of Amaranthus (herbs) which smells like garlic (Angelovicova, 1997). Yolk cholesterol values found in the current study, when hens were comparable with those of Jiang *et al*. (1991), who reported 14.6 mg g^{-1} yolk using the same procedure in White Leghorn hens.

Table 5: Effects of dietary garlic on egg yolk cholesterol concentrations in commercial laying hens (mg g^{-1})

Diets	Week 3	Week 4	Week 5	Week 6
0% garlic powder	13.8[a]	13.7[a]	13.9[a]	14.0[a]
2% garlic powder	12.9[b]	13.0[b]	13.3[b]	13.2[b]
6% garlic powder	11.6[c]	12.1[c]	11.6[c]	12.0[c]
8% garlic powder	10.0[d]	11.8[d]	11.2[d]	10.7[d]

[a-d]Means with the different superscript within column are significantly different ($p<0.01$). [1]Data are reported at least square means n = 6

Some contradictory results about hypocholesterolemic effect of dietary garlic were due to use of different commercial garlic products. These studies have suggested that commercial garlic oil, garlic powder and commercially available garlic extract may not be hypocholesterolemic (Berthold *et al*., 1998; Isaacsohn *et al*., 1998; McCrindle *et al*., 1998). The different commercial garlic products may be divided into allicin-rich products and non-allicin rich products. The former are made from raw garlic and the latter are made from processed garlic. All may differ significantly in the substances they contain (Kasuga *et al*., 2001). The use of oven dried (at low temperature i.e., 55°C) garlic powder in the present study maximized the possibilities of the presence of active components.

CONCLUSION

Supplemental oven dried garlic powder decreased serum and yolk cholesterol concentrations without adverse effect on layer performance. Oven dried garlic powder up to 8% can be used as a hypocholesterolemic agent in practical layer diets.

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