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Effects of Dietary Garlic Powder on Cholesterol Concentration in Native Desi Laying Hens

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Abstract: The research was conducted to evaluate the potential for local dietary garlic to influence egg yolk and blood cholesterol concentrations and overall performance of native desi layers. Forty 30-week-old desi 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. The results showed that differences among diets in weight gain and egg production were found significant ($p<0.01$) as averaged over 6 week. However, no differences ($p>0.05$) were observed among diets in feed intake, feed efficiency, egg weight and egg mass with increasing levels of dietary garlic. Serum and egg yolk cholesterol concentrations decreased ($p<0.05$) with increasing levels of dietary garlic. It may be concluded that dried garlic powder in the diets of desi laying hens reduced serum and yolk cholesterol concentrations and dietary garlic powder had better effects on layer performance.

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

INTRODUCTION

Garlic (*Allium sativum*) has acquired in the folklore of many cultures as a therapeutic agent (Amagase *et al*., 2001). According to folk medicine, garlic was used to treat cardiac disease (Essman, 1984). Some clinical reports, including meta-analyses, have described the hypocholesterolemic effect of garlic in human (Warshafsky *et al*., 1993; Silagy and Neil, 1994). Some studies, however, suggested that commercial garlic oil, garlic powder and commercially available garlic extract may not be hypocholesterolemic (Berthold *et al*., 1998; McCrindle *et al*., 1998). Although the reason for this is unknown, it likely relates to preparation methods, the stability of chemical components and the duration of the study (Amagase *et al*., 2001).

Animal studies suggest that garlic has potential hypolipidemic, hypoglycemic, hypotensive and hypothrombotic properties (Bordia *et al*., 1975; Shoetan *et al*., 1984). The biochemically active constituent of garlic is allicin (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 is responsible for smell of garlic (Murad and Baseer, 1997). Moreover, chronic exposure to small amount of tellurium found in garlic may reduce endogenous cholesterol production through inhibition of hepatic squalene epoxidase (Barhagallo *et al*., 1998). Garlic paste (3.8%), solvent fractions, or garlic oil equivalent to this amount reduced serum cholesterol by 18 and 23% in broilers and 12-week-old leghorn pullets, respectively, when diets were fed for 4 week (Qureshi *et al*., 1983b). Experiments in which garlic was fed to 5-week-old male broilers for 3 week and *in vitro* studies with chicken hepatocytes exposed to polar fractions of garlic powder (garlic equivalent to 1, 2, 4, 6 and 8% fresh garlic paste) showed a dose-dependent inhibition of hepatic HMG-CoA reductase, cholesterol 7α-hydroxylase and fatty acid synthetase (Qureshi *et al*., 1983a). Sklan *et al*. (1992) reported decreased hepatic cholesterol concentration in chicken when 2% garlic was fed for 14 days. However, Birrenkott *et al*. (2000)

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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).

In Pakistan, rural poultry is one of the important segments of poultry production which contributes about 42 and 60% in poultry meat and eggs produced in the country, respectively (Sahota and Bhatti, 2003). Most of work on garlic supplementation has been carried out in commercial layers (Rehman, 2001; Ashfaq, 2001) but there is no research done on native desi layers in Pakistan. Therefore, the current study was planned to characterize the hypocholesterolemic effects of various levels of local oven-dried garlic powder in the diets of native desi laying hens.

MATERIALS AND METHODS

Experimental Birds and Diets

Forty, 30-week-old hens of desi 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 weeks. The basal diet was formulated to meet the nutrient requirements of laying hens (NRC, 1994). The basal diet was supplemented with 0 (control), 2, 6 and 8% oven dried garlic powder. The composition of the experimental diets is shown in Table 1. The nutrient composition of experimental diets is given in Table 2. The proximate analysis and cholesterol concentration of each experimental diet was done at feed testing laboratory of Poultry Research Institute, Rawalpindi. The other nutrients were calculated on the basis of available nutrient composition of each ingredient. Feed and water were provided *ad libitum*.

Source and Preparation Methods for Dietary Garlic

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 hot air oven trays 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 weeks.

Table 1: Composition of experimental basal diet

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

Experimental Parameters

Birds were randomly assigned to four diets and fed daily. Body weight was measured weekly and body weight gain was recorded. Weekly feed consumption was recorded and feed efficiency was calculated during the 6 weeks 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. 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 were analyzed for dry matter, crude protein, crude fat and crude fibre according to the AOAC (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, 1982).

RESULTS AND DISCUSSION

Cholesterol concentrations in all diets were observed low and similar to those found in the control diet (Table 2). The first 2 week that garlic was added as a supplement to the diet allowed the birds to be acclimatized with the experimental diets.

Layer Performance

The birds fed diets containing garlic gained more weight ($p<0.01$) than those of birds fed diets without garlic (Table 3). Similar trend was observed in egg production. However, feed consumption, feed efficiency, egg weight and egg mass were not affected by diet ($p>0.05$) as averaged over the 6 week period (Table 3). The results of the present study are in line with the findings of Samanta and Dey (1991), who reported that Japanese quails gained more weight and egg production ($p<0.05$) without affect on feed consumption and feed efficiency with garlic powder. This effect was attributed to allicin,

Table 2: Nutrient composition of experimental diets after supplementation of garlic powder

	Garlic powder in diets (%)			
Nutrients	0	2	6	8
M (kcal/kg)	2740.00	2799.00	2804.00	2813.00
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

Table 3: Effects of dietary garlic on performance of desi laying hens

Items	A	B	C	D
Weight gain (g week^{-1})	50.00^{d}	58.00^{c}	66.00^{b}	78.00^{a}
Egg production (%)	27.77^{b}	30.80^{a}	31.60^{a}	32.80^{a}
Egg weight (g)	39.50	40.40	40.50	40.53
Egg mass (g day^{-1} hen^{-1})	10.97	12.44	12.80	13.29
Feed consumption (g day^{-1} hen^{-1})	105.00	110.00	115.00	119.00
Feed efficiency (feed intake:eggmass) (g:g)	9.57	8.84	8.98	8.95

^{abc}: Means with the different superscripts 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 desi laying hens (mg/100 mL)[1]

	Week (mg g^{-1})			
Diets	3	4	5	6
Garlic powder (%)				
0	157^{a}	157^{a}	160^{a}	160^{a}
2	123^{b}	126^{b}	127^{b}	127^{b}
6	105^{c}	103^{c}	99^{c}	99^{c}
8	86^{d}	84^{d}	84^{d}	81^{d}

^{abc}: Means with the different superscripts within column are significantly different ($p<0.01$); [1]: Data are reported at least square means n = 6

an active component, present in garlic powder which inhibits the growth of pathogenic bacteria and aflatoxin producing fungi. Ashfaq (2001) also reported that supplementation of garlic powder had non-significant ($p<0.05$) effect on egg weight in commercial layers. Reddy *et al*. (1991) however, reported that body weight gain and egg production in Babcock layer with 0.02% garlic oil was not affected during the 8 weeks trial. The reason of this difference might be the use of low level of garlic concentration and commercial garlic oil. El-Habbak *et al*. (1989) reported that egg weight in commercial layers increased with supplementation of ethanol extracted garlic because of egg laying rate was decreased. However 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 of the study (Table 4). In this study, 2, 6 and 8% garlic powder reduced serum cholesterol concentrations on average over 6 weeks by 20.6, 38.12 and 50.62%, respectively. 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 supplementation of garlic paste, a solvent extracted garlic paste and commercial garlic oil. This reduction in cholesterol concentration with supplementation of garlic was attributed 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 needed in the synthetic pathway of cholesterol. The cholesterol concentrations in desi laying hens fed the control diet in the current study were higher (157-160 mg/100 mL) than those reported by Bhatti *et al*. (2003), who observed 140 mg/100 mL plasma cholesterol in desi hens when fed similar levels of crude fibre as the current study. This variation may be due to differences in analytical techniques and ages of birds (Yeh Suhni *et al*., 1996).

Egg Yolk Cholesterol

Cholesterol concentrations per gram of yolk decreased ($p<0.01$) with increasing levels of garlic powder in the diet (Table 5). Dietary garlic at 2, 6 and 8% reduced egg yolk cholesterol, on average over

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

	Week (mg g^{-1})			
Diets	3	4	5	6
Garlic powder (%)				
0	11.6[a]	11.7[a]	11.80[a]	11.9[a]
2	10.7[b]	11.0[b]	11.10[b]	11.2[b]
6	9.4[c]	10.1[c]	10.20[c]	10.3[c]
8	7.8[d]	9.8[d]	9.9[d]	10.0[d]

[abc]: Means with the different superscripts within column are significantly different ($p<0.01$); [1]: Data are reported at least square means n = 6

6 weeks, by 5.7, 14.28 and 23.57%, respectively. Sharma *et al*. (1979) also 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 weeks. Similarly, egg yolk cholesterol was decreased by 7.28 and 6.83% through feeding diets containing 5 and 10% of Amaranthus (herbs) which smells like garlic (Angelovicova, 1997). Yolk cholesterol values of desi birds were found lower 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.

Some earlier 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). Some contradictory results about hypocholesterolemic effect of dietary garlic might be due to use of different commercial garlic products. 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.

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

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