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Use of Garlic as a Hypocholesterolemic Dietary Additive in Laying Hens

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ABSTRACT

An experiment was carried out with laying hens to investigate the effect of feeding garlic at low dietary concentrations on cholesterol metabolism and productivity of laying hens. Sixty, 57 weeks old laying hens belonging to Shaver 579 strain was fed garlic at different dietary levels for 10 weeks. Five dietary treatments, each of four replications, containing either 0, 5, 15, 25 or 35 g garlic per kg were compared. The birds were reared in a pyramid-type laying cage during the experimental period. Blood and eggs were collected three times for the determination of cholesterol concentration in serum and yolk. Laying performance in terms of body weight gain, egg weight, total egg mass and FCR were recorded. Use of garlic at increasing concentration showed negative linear effects ($p<0.01$) on total lipids, yolk cholesterol and serum cholesterol. Analysis of performance data showed no significance differences from the control group except a linear increase in total egg mass and hen day egg production ($p<0.01$). It may be concluded that garlic can be considered as a hypocholesterolemic dietary feed additive in older hens but further feeding trials with dietary inclusion levels between 25 and 35 g kg^{-1} would be useful to establish these results.

Key words: Garlic, laying hens, serum cholesterol, yolk cholesterol, laying performance

INTRODUCTION

The egg fat is often criticized for its cholesterol content. Daily consumption of no more than 300 mg of cholesterol has been recommended to avoid elevation in blood cholesterol and reduce the risk of coronary heart disease (Weggemans *et al*., 2001). An egg of 60 g weight contains about 200-250 mg cholesterol and the perception to eggs by the public as a major source of dietary cholesterol is seen as a significant factor contributing to the overall decline in its consumption (Yaffee *et al*., 1991). Poultry nutritionists are trying to reduce cholesterol in eggs by various ways. This has involved a number of different approaches, including genetic selection and nutritional or pharmacological manipulation. Nutritional manipulation of egg yolk cholesterol has appeared to be the most important in reducing yolk cholesterol concentration. A reduction of yolk cholesterol by 34% was found when laying hens were fed with pharmacological amounts of copper (Pesti and Bakalli, 1998), Report is also available that feeding hens with whole chia seed (*Salvia hispanica* L.) up to 28% of the diet resulted in a reduction in yolk cholesterol of ~20%. Reduction of cholesterol by 15, 28, 32 and 43% was possible when hens were fed garlic paste at 2, 4, 6 or 8 g kg^{-1} diet, respectively (Chowdhury *et al*., 2002). Production of omega eggs was possible by feeding hens a flaxseed-based diet that contained 180 mg cholesterol that the standard

value of 213 mg (Lewis *et al.*, 2000). To author's knowledge, very limited research results are available on garlic as a hyocholesterolemic agent in laying hens particularly in older hens. Interest to consider garlic as a hypocholesterolemic agent arose from the results of an earlier study conducted in this laboratory, where a significant reduction in cholesterol content (by>30%) in laying pullets was observed (Chowdhury *et al.*, 2002). Since, garlic contains a variety of organosulfar compounds, some of which may be responsible for its therapeutic properties (Rybak *et al.*, 2004); use of low dietary levels to investigate its hypocholesterolemic effect in layer diet could be useful. Therefore, an attempt was taken in this study to investigate the hypocholesterolemic effect of garlic at low dietary concentrations and its effects on laying performance. Objectives of the study were to determine whether garlic had any reducing effect on cholesterol concentration in serum and yolk and to investigate its effects on egg production characteristics on laying hens.

MATERIALS AND METHODS

Experimental birds and diets: Sixty, 57 weeks old laying hens belonging to Shaver 579 strain were considered to conduct the feeding trial. Chickens were almost uniform with regard to body weight. The birds were reared in cages measuring 52×50×52 cm (length, width and height). Three birds were considered as an experimental unit and kept in each cage. Five dietary treatments, each of four replications, containing 0, 5, 15, 25 or 35 g garlic per kg feed were compared. The duration of trial was 10 weeks.

Measurement of experimental parameters: The birds were exposed to similar care and management in all dietary groups throughout the experimental period. Egg production and feed consumption were recorded daily, while body weight was recorded twice in a month, initially and at the end of trial. Egg weight was recorded at the middle of each week. Feed conversion ratio, body weight gain and survivability were calculated. For the analysis of cholesterol eggs were collected three times during the study period. Eggs were subsequently cooked well (Anonymous, 1981) for easy separation of yolk and preserved between 4 and 8°C until analyses were carried out.

Blood collection and separation of serum: Blood (3-4 mL) was collected from each bird from the wing vein using sterilized syringe with needles. Serum samples were separated and stored at -20 to -2°C until cholesterol analysis.

Chemical analysis of yolk and serum: About 3 g hard-cooked yolk sample was taken in a centrifuge tube and sonnicated with 15 mL g^{-1} of chloroform: methanol (2:1, v/v) solvent mixture and was kept overnight for complete extraction of lipid. Total lipids in egg yolk were detected according to Solver *et al.* (1978). Cholesterol concentration in egg yolk was determined by following the Libermann Burchard method (Solver *et al.*, 1978). Serum cholesterol was determined with the help of diagnostic kits (Cholesterol Liquicolor Complete Kit. HUMAN GMBH-GERMANY).

Statistical analysis: Data were analyzed by analysis of variance using the General Linear Model Procedure of SAS (SAS, 2000). Orthogonal ploynomial contrasts were used to determine the nature of responses to increasing concentrations of garlic in the diets. Least Significant Differences (LSDs) were calculated where significant variation in any trait was observed among different diet groups.

RESULTS AND DISCUSSION

Cholesterol and related parameters

Yolk weight: The yolk weight in different dietary groups were close to each other and did not differ significantly except at 67 weeks of age when a positive quadratic effect ($p<0.01$) was found. It was interesting to note that yolk weight slightly increased as the level of garlic gradually increased up to 25 g kg^{-1} and then reduced at 35 g kg^{-1} dietary level (Table 1). Feeding garlic to Japanese quail (Habbak *et al*., 1989) and garlic to different layer strains (Chowdhury *et al*., 2002) as hypocholesterolemic agents showed results similar to this study.

Total lipids in yolk: The highest and the lowest value for total lipids were 33.4 and 26.6 g/100 g yolk for the control and 35 g kg^{-1} level, respectively at 67 weeks. The results of total lipids showed a negative linear effects ($p<0.01$) with the advancement of age. The lipid content decreased at 25 g kg^{-1} at 61 and 65 weeks and then increased slightly but at 67 weeks there was a reduction at 35 g kg^{-1} dietary level. The results clearly indicate that lipid content in garlic fed layers may decline, although a significant ($p<0.01$) linear decreasing trend was visible at 61 weeks of age.

Serum and yolk cholesterol concentration: Although, serum cholesterol concentrations showed a declining trend, in general, due to dietary inclusion of garlic, no significant differences in data were apparent during 65 and 67 weeks of age. But serum cholesterol concentration showed a negative linear result ($p<0.01$) at weeks of age. In this case, it was reduced by 33% at 35 g kg^{-1} dietary inclusion level than the control group. Feeding Ecozyme^{R}, a probiotic and Ratilose^{R}, a preboitic to White Leghorn hens for four weeks that reduced serum cholesterol by 14.16% (Chen and Chen, 2003). It has been showed that ProlacR 118 in White Leghorn hens at 100 and 200 ppm reduced serum cholesterol by ~14 to 19% and 20%, respectively (Panda *et al*., 2003). A reduction of 30% serum cholesterol in human was possible by feeding neem (*Azadirachta indica*) leaf meal.

The effect of garlic on yolk as hypocholesterolemic ingredient in shown in Table 2. Significant negative linear effects ($p<0.01$) was observed at 61, 65 and 67 weeks of age by supplementing layer diet with garlic. At 67 week, both the negative linear ($p<0.01$) and quadratic effect ($p<0.01$) was found. The result obtained from yolk cholesterol showed that there was a reduction of approximately 17, 14 and 14 mg g^{-1} yolk during 61, 65 and 67 weeks, respectively when the layers were supplied with 35 g kg^{-1} diet. It indicates that dietary supplementation of garlic up to 35 g kg^{-1} level had depleting effect on yolk cholesterol. Previously reduction of yolk cholesterol by 15, 28, 32 and 43% was found when garlic paste was fed at 20, 40, 60 or 80 g kg^{-1}, respectively

Table 1: Yolk weight (g) and total lipid in yolk (g/100 g) of laying hens fed different dietary levels of garlic (57-67 weeks)

		Dietary levels of garlic (g kg^{-1})						
Parameters	Age (week)	0	5	15	25	35	Linear effect	Quadratic effect
Yolk weight (g)	61	18.2	19.6	20.5	19.1	18.7	NS	NS
	65	19.0	19.6	20.1	20.2	19.0	NS	NS
	67	17.6	19.1	20.2	20.3	18.0	NS	**
Total lipids in yolk (g/100 g)	61	30.7	30.4	30.1	28.3	29.9	**	NS
	65	32.0	31.1	30.6	30.1	30.3	NS	NS
	67	33.4	31.2	31.5	30.6	26.6	NS	NS

** $p<0.01$, NS: Non-significant

Table 2: Serum cholesterol (mg dL^{-1}) and yolk cholesterol 7 (mg g^{-1} yolk) concentration of laying hens fed different dietary levels of garlic

		Dietary levels of garlic (g kg^{-1})						
Parameters	Age (week)	0	5	15	25	35	Linear effect	Quadratic effect
Serum cholesterol (mg dL^{-1})	61	286.5^{b}	222.2^{a}	207.4^{a}	200.0^{ab}	191.9^{a}	**	NS
	65	257.1	210.4	212.3	239.6	200.0	NS	NS
	67	289.8	245.3	215.7	229.6	222.5	NS	NS
Yolk cholesterol (mg g^{-1} yolk)	61	11.5	11.1	10.9	10.4	9.5	**	NS
	65	12.0^{a}	11.1^{b}	10.9^{b}	10.9^{b}	10.3^{b}	**	NS
	67	12.8^{a}	11.5^{ab}	11.5^{bc}	11.0^{bc}	11.0^{c}	**	$**^{a}$

^{bc}Means with uncommon superscript letters are significantly different, ** $p<0.01$, NS: Non-significant

Table 3: Productive performance of laying fed diets containing garlic at different levels

	Dietary levels of garlic (g kg^{-1})						
Variables	0	5	15	25	35	Linear effect	Quadratic effect
Feed consumption (g/bird/d)	116.5	117.2	115.6	118.1	118.2	NS	NS
Total egg mass	40.0	47.5	48.1	44.2	47.4	**	**
Hen day egg production (%)	62.7	73.6	72.4	69.8	72.0	*	*
Egg weight (g)	63.7	64.5	65.1	63.4	64.8	NS	NS
Feed conversion ratio	2.77	2.51	2.57	2.72	2.48	NS	NS
Body weight gain (g)	370	340	306	250	333	NS	NS

**$p<0.01$, *$p<0.05$, NS: Non-significant

(Chowdhury *et al*., 2002). Report is also available that a reduction of yolk cholesterol by 34% is possible when copper is used at pharmacological amounts (Pesti and Bakalli, 1998). Feeding hens whole chia seed (*Salvia hispanica* L.) up to 28% of the diet resulted in a maximal reduction in yolk cholesterol of ~20% (Ayerza and Coates, 2000).

Laying performance: Supplementation of garlic at 5-35 g kg^{-1} layer diet showed a significant positive quadratic effect on total egg mass and hen day egg production but other laying performance remain unaffected. The result (Table 3) showed that addition of garlic in the diet up to 15 g kg^{-1} significantly increased total egg mass ($p<0.01$) and hen day egg production ($p<0.05$) as compared to control group. The mean value of feed consumption, egg weight and body weight gain were almost similar to that of control group. This result agreed with the results of feeding garlic paste at higher levels as reported previously (Chowdhury *et al*., 2002). Garlic oil based diet did not affect egg weight significantly and use of sun-dried garlic paste in six layer strains could not alter egg weight. In this study, garlic up to 35 g kg^{-1} levels reduced FCR values in spite of higher feed consumption as compared to control group ($p>0.05$). Feeding sun-dried garlic paste up to 80 g kg^{-1} could not significantly affect FCR among the strains (Chowdhury *et al*., 2002).

CONCLUSIONS

The results of the study revealed that garlic had depleting effects on both serum cholesterol and yolk cholesterol up to a certain dietary level of inclusion. This dietary level probably lies between 15-35 g kg^{-1}. A similar level of inclusion may be effective in reducing total lipids in egg yolk in spite of little increases in yolk weight at 15 and 25 g kg^{-1} level. Laying performance was not affected except a reduction in body weight gain above 5 g kg^{-1} dietary level ($p>0.01$). It may be concluded that garlic can be considered as a hypocholesterolemic dietary feed additive in older hens and that

when used as a dietary additive, the laying performance may be either equal to or better than the control group. A further feeding trial with dietary inclusion levels between 15 and 35 g kg^{-1} would be helpful. The cost effectiveness of such trial may also be examined.

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