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EFFECT OF FEEDING GARLIC ON QUANTITATIVE AND QUALITATIVE PRODUCTIVITY OF LAYING HENS

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SUMMARY

The effects of feeding corn-soy bean diet supplemented with different garlic regimens on laying hens were studied. Hy-line hens at sexual maturity were randomly assigned to fresh ground garlic at 5 g /hen/day for one day a week (treatment b); 3 days a week (treatment c) or 6 days a week (treatment d). Garlic-fed hens were compared with control birds (treatment a) that only received plain diet. The results indicated that egg yolk cholesterol reduced due to garlic feeding ($p<.001$). However, this reduction was not significant in the first fifteen days of the treatments. Removal of garlic from the diet resulted in increasing cholesterol to that of the control level. Additionally, ovary weight was significantly increased ($P<.05$) one month after garlic withdrawal from the diet. However, no effect were observed on final body weight, weight of edible parts (liver, heart and gizzard), intestine weight or abdominal fat deposition. Egg mass and egg quality in the different treatments were analyzed in four 15-d collecting periods. Egg mass was improved in treatment d, wherein garlic was predominantly fed. Egg quality data, measured as Haugh Units (HU), were significantly ($P<.001$) reduced due to period effects rather than treatment effects. Furthermore, eggshell thickness was reduced due to interaction effects ($P<.05$). On the other hand, no effects were found in feed conversion (g diet/ g egg produced) or average egg weight. Serum cholesterol, calcium and total protein were not highly correlated. On the contrary, correlation between glucose

and cholesterol was significantly high (P<.01) and the relationship was clearly influenced by garlic feeding in an opposite direction (r= -0.92). Serum cholesterol and egg yolk cholesterol were highly correlated (r= 0.95). The overall pattern seemed to be dependent on the amount of garlic received by hens.

Keywords: Hens, garlic, egg production, blood parameters, feed conversion

INTRODUCTION

Many research efforts were directed towards the reduction of egg yolk cholesterol to meed a recommended level of less than 300 mg cholesterol/day in human diet (Brown, 1990 and Cannon, 1990). This objective involved a number of different approaches to possibly alter cholesterol deposition in chicken eggs. Nutritional factors including dietary fat (Sim & Bragg, 1977; Weiss et al., 1964; and Hirata et al., 1986); dietary fiber (Turk & Barnett, 1972; Weiss & Scott, 1979 and Vargas & Naber, 1984); and dietary micronutrients, i.e., ascorbic acid (Constantin & Neagu, 1983; Weiss et al., 1967) were studied for their impact on egg cholesterol. Overwhelming evidence indicated that egg yolk cholesterol level was less sensitive to change (Griffin, 1992) due to tight regulatory mechanisms inherited in the laying hens. Nevertheless, it appears that there are still some concepts to be approached for controlling egg yolk cholesterol in the desired direction.

Garlic (Allium sativum L.) a well known hypotensive plant, has been recognized as a therapeutic agent for hypertension. In a conclusive review by Mesbah and Aboul-Ela (1991), garlic was reported to possess several biological activities, e.g., hypoglycemic, hypolepimic, antioxidant, detoxifier of heavy metals and an immune system modulator. The aforementioned biological activities have encouraged us to hypothesize that garlic may affect cholesterol accumulation in serum and egg yolk of laying hens and the effects could be desirable for the birds and their human consumers.

MATERIALS AND METHODS

Sixty, Singly Comb White Leghorn hens (Hy-Line) were

randomly chosen from a large flock that was previously obtained from a commercial source. Hens were at the age of sexual maturity with an average rate of egg production (80%) and a similar body weight (1330 g± 12.8). Birds were assigned to a standard individual wire-mesh cages where feed and water were provided ad. lib. and hens were exposed to 16 hr. incandescent light/day. The hens were 28 week-old at the beginning of the experiment which started at the end of January. Two weeks prior to the commencement of the trial, a pilot test was carried out wherein a group of birds (10-15) were fed different levels of fresh ground garlic which was manually mixed with control diet to decide for the maximal amounts of garlic birds can daily accept. Force feeding the whole clove was time consuming. Therefore, fresh ground garlic composed of cloves surrounded by a thin white tough papery skin was supplemented daily at 5g to corn-soybean diet (Table 1). The diet met all nutritional requirements recommended by the NRC (1984). Birds were divided into 4 treatments; treatment (A): control diet without garlic supplementation, treatment (B): control diet plus 5 g garlic for one day/wk/hen, treatment (C): control diet plus 5 g garlic for 3 days/wk/hen and treatment (D): received the control diet plus 5 g garlic for 6 days/wk/hen. Both the control and treated diets were fed to birds for period of 2 months. Egg production and average egg weight were recorded daily, while egg mass, egg quality (Haugh Units) and egg shell thickness were recorded every 15 days/hen. Concentration of egg yolk cholesterol (8 eggs/treatment) for all treatments was determined by a newly developed HPLC method (ElDeeb and Emara, 1994) in eggs collected at periods 15, 30, and 60 days. Also, egg samples were collected one month after garlic removal from hens diet (90 days) and assayed for cholesterol as well. Blood samples (8 birds/treatment) were withdrawn from wing vein at the end of the experiment (60 days) and 32 hens (8 birds/ treatment) were killed for body measurements, abdominal fat deposition, weight of edible parts (heart, liver and gizzard), ovary, oviduct and intestine weight and oviduct length. Serum cholesterol levels were determined using kits from Biocon, Germany. While serum calcium, glucose and total protein were determined using kits from Diamond, Egypt.

Table 1. Diet Composition

Ingredients	g/100 g
Yellow Corn	69.9
Soybean meal (44%, CP)	11.0
Layer concentration (51%, CP)[1]	10.0
Limestone	6.5
Bone meal	1.0
Wheat bran	1.5
DL-methionine	0.1
Calculate analysis	
CP%	16.40
ME, Kcl per Kg diet	2865.00
Calcium %	3.75
Available phosphorus	0.55

[1] Vitamins and minerals supplemented/Kg concentrate, vit. A 130,000 IU; vit. D3 26,000 IU; vit. E 120 IU; vit B12 150 ug; vit. K3 MSB 16 mg; vit B2 50 mg; Ca-pantothenate B3 120 mg; Nicotinic acid pp 250 mg; Thiamine B1 15 mg; Folic acid 15 mg; Pyridoxin B6 15 mg; Biotin 1.5 mg; Betain-choline-HCl 5000 mg; Mn 700 mg; Zn 600 mg; Fe 400 mg; Cu 40 mg; Iodine 7 mg; Co 2 mg; Se 1.5 mg; B.H.T. 1250 mg; Zinc baciteracin 150 mg.

All the data were analyzed by Analysis of Variance (ANOVA) using General Linear Model Procedure (GLM) of SAS software (SAS Institute, 1987) followed by correlation analyses. Significant differences between treatments mean were determined using SNK with a predetermined 5% probability level. Because the effect of garlic on average egg weight, HU and feed conversion were generally consistent, the data were summed over the total treatments and tested for a period effect by means separation test.

RESULTS AND DISCUSSION

The concentration of egg yolk cholesterol (Table 2) decreased sharply in hens received diet supplemented with different garlic regimens (treatments B, C and D) $P<.001$. However, reduction in cholesterol levels was not

detectable during the first 15 days (period 1) when treatments were applied to birds. During period 2 (30 days), egg yolk cholesterol (mg/100 g yolk) was reduced by about 5.5%, 8.3% and 7.7% in treatments B, C and D, respectively (P<.001). Also, further decline in cholesterol values continued during period 3 (60 days) wherein 14.2%, 23.3% and 20.5% reduction were reported. The trend of reduced amounts of cholesterol over periods 2 and 3 was equal in both treatment C and D. Interestingly, hens were physiologically able to regain the cholesterol level similar to control bird, following the removal of garlic from the diet (Figure 1). In their valuable review, Mesbah and Aboul-Ela (1991) reported that allicin, one of the active components present in garlic, reacts with bioactive molecules containing sulfhydryl groups including coenzyme A that is necessary for the biosynthesis of cholesterol. This interpretation supports our results since all treated birds were able to regain the normal cholesterol level when the extrinsic effects of allicin was prevented through removal of garlic from the diet.

Table 2. Cholesterol content (mg/100g yolk) in eggs laid by hens fed garlic and following the withdrawal of garlic from the diet (at 90 days)

Treatment[1]	Period (sampling time-days)				No. of eggs period (n)
	15	30	60	90	
A	390±2.8	390±2.1	393±2.8	389±3.0	(8)
B	386±3.0	369±1.6	341±2.9	390±2.9	(8)
C	388±3.5	359±2.2	311±2.5	391±2.3	(8)
D	390±2.3	361±2.2	320±2.2	389±3.6	(8)

ANOVA	Probability levels
Treatment	P<.001
Period	P<.001
Treatment x Period	P<.001

[1] Hens were assigned to one of the following treatments: A Corn-Soybean diet supplemented with 0 garlic, B Control diet plus 5 g garlic 1 day/wk/hen, C Control diet plus 5 g garlic 3 days/wk/hen, D Control diet plus 5 g garlic 6 days/wk/hen.

Egg mass data, total eggs laid/hen/15 days, indicated that hens fed garlic predominantly (treatment D) had the highest value (P<.05) among all over treatments (Table 3). In addition rate of laying, generated from

egg mass data, was higher in treatment B and D (85% and 85.7%, respectively) than the control by about 5%. However, no effect due to feeding garlic on average egg weight, or feed conversion was evident. Shell thickness and HU (Table 4) were reduced due to interaction effect between treatment and period (time sampling of eggs); $P<.05$. It is important to declear that during time sampling especially at 30 and 45 days, birds were exposed to heat wave with an increase in relative humidity. Recorded environmental temperature was 29.2°C (max.) and 3.6 (min.), while recorded humidity was 92% (max.) and 27% (min.). This may explain the reduction and inconsistent data HU and shell thickness. This agreed with the results obtained by Silversides et al., (1993) who reported a decline in HU and albumin quality during hot climate. No differences were observed in body weight, fat deposition, edible parts or small intestine weights (Table 5). The linning of the gizzards and stomach was examined carefully for any sign of hemorrhages due to garlic feeding. No indication of errosion or hemorrhages was found. This reveals that feeding 5 g of garlic/hen/day for 3 or 6 days/wk had no harm effect on the mucosal or the linning of G.I. tract. Physical characteristics of sex organs (Table 5) showed no differences due to treatment effects as indicated by weight of ovary and oviduct or the length of the oviduct. When garlic was removed from the diet, however, ovary weight increased significantly ($P<.05$). This may be due to a latent period of production, thereby developing new follicles that resulted in total increase in ovary weight.

Blood parameters were studied in relation to garlic feeding (Table 6). Results obtained showed that serum glucose level was significantly higher in treatment D ($P<.05$). To the contrary, garlic administration for 2 months decreased glucose levels in fasted patients (review by Mesbah & Aboul-Ela, 1991). The contracting results could be explained that avian is in fact diabetic (Sturkie, 1986). Serum levels of protein, cholesterol and calcium were reduced in the same treatments ($P<.05$). This reduction resulted in values that were still in the range of physiological values. When garlic was removed, no consistant pattern was observed for the parameters depicted in Table 6. Correlation between total protein, calcium and

cholesterol seemed to be less dependent on garlic treatment, while that involved glucose was clearly influenced by garlic feeding in the opposite direction ($P<.05$). Interestingly, positive correlation between serum cholesterol and egg yolk cholesterol was evident ($P<.01$) and clearly dependent on garlic treatment (Figure 2). This result agreed with previous finding by Sim and Bragg (1977). Different results were obtained by Beyer & Jensen (1993), indicating that substantial reduction in serum cholesterol was not associated with a reduction in egg cholesterol due to feeding sorbose to laying hens. Also, Sloan et al. (1994) found that serum cholesterol was not closely associated with the concentration of yolk cholesterol in laying hens fed different levels of cholecalciferol.

Egg has always been considered a rich source of nutrients and an important part of the diet, but cholesterol has given egg a bad rap. The industry has suffered in recent years from worries about cholesterol and other factors. Our results revealed that feeding hens with garlic resulted not only in Lowering egg cholesterol but also increasing rate of egg production. Also, garlic taste was declared in our taste panel that may not be desired by consumers. If people who suffer hypertension and heart disease are able to ingest garlic (as whole clove) or garlic extracts due to its hypotensive effect, whey worry about the taste of garlic in eggs. Therefore, this study suggest that feeding garlic to laying hens be considered by professional egg industry.

Table 3. Effect of feeding garlic on feed conversion, total egg mass/hen/15 days and average egg weight in laying hens

Treatment[1]	Feed conversion	Total egg mass hen/15 days(g)	Average Egg weight(g)
A	2.2	670^{b2}	55.4
B	2.1	690^{ab}	54.2
C	2.1	658^{b}	55.2
D	2.1	704^{a}	54.7
SEM	0.08	11.9	0.50

1 Same as footnote 1 in Table 2. Means within columns with no common superscript differ significantly ($P\leq.05$).

Table 4. Effect of feeding garlic on egg quality (HU) in different period in laying hens

Treatment[1]	Period (Sampling time-days)				
	15	30	45	60	X±SE
			H.U		
A	94	81	87	86	
B	95	78	81	87	
C	95	80	85	92	
D	93	83	89	91	
X±SE	94±0.47[a2]	81±1.04[c]	86±1.7[b]	89±1.5[b]	
			Shell thickness (mm)		
A	0.39	0.39	0.33	0.32	.35±0.01
B	0.39	0.38	0.31	0.33	.35±0.02
C	0.38	0.39	0.35	0.32	.36±0.01
D	0.39	0.38	0.35	0.34	.36±0.01
X±SE	0.38±.002	0.38±.003	0.33±.009	0.32±.004	

1 Same as footnote 1 in table 2.
2 Means within columns with no common superscript differ significantly (P≤.05).

Table 5. Effect of feeding garlic for two months on final body weight and fresh weight of edible parts[1], intestine, abdominal fat, ovary, oviduct and oviduct length in laying hens

Paramters	Treatment[2]				
	A	B	C	D	SEM
Body weight (g)	1436	1402	1423	1407	34.4
Edible parts (g)	74	72	76	78	2.9
Intestine (g)	74	79	80	78	2.9
Abdominal fat (g)	41	33	46	40	4.0
Ovary (g)	36	38	37	39	2.1
Oviduct (g)	62	56	64	59	3.0
Oviduct (cm)	69	74	71	72	2.3

1 Edible parts consists of; heart, liver and gazzard
2 Same as footnote 1 in table 2.

Table 6. Serum levels of cholesterol, glucose, total perotein and calcium during feeding garlic (60 days) and after garlic withdrawl from diet (90 days)

Treatment[1]	Periods (days)	
	60	90
	Cholesterol mg/100 ml	
A	192[a2]	186
B	157[ab]	167
C	144[b]	190
D	120[b]	124
SEM	15.0	14.9
	Glucose mg/100 ml	
A	208[b]	218
B	217[b]	242
C	214[b]	241
D	240[a]	232
SEM	7.0	5.6
r	-0.92	
	Total protein mg/100 ml	
A	5.6[a]	5.5
B	5.0[ab]	5.9
C	5.6[a]	7.1
D	4.9[b]	6.0
SEM	0.18	0.34
	Calcium mg/100 ml	
A	21.9[a]	19.2
B	21.4[a]	20.8
C	22.2[a]	21.7
D	19.7[b]	20.7
SEM	0.55	0.51

1 Same as footnote 1 in table 2.

2 Means within columns with no common superscript differ significantly ($P \leq .05$).

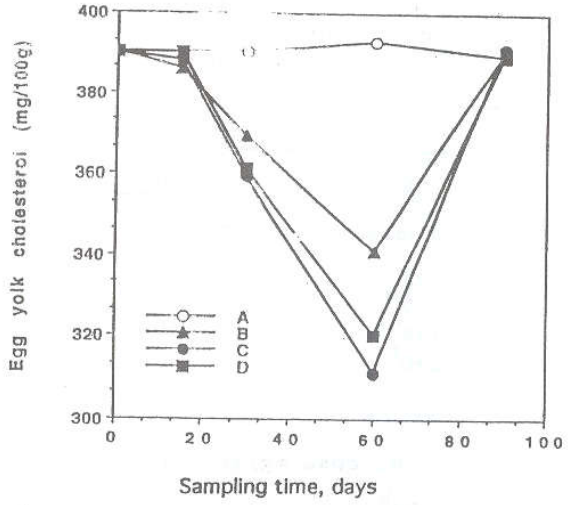

Fig. 1. Cholesterol concentrations in egg yolk from laying hens fed basic diet (A) or basic diet supplemented with garlic at 5 g/hen/day for one day(B); three days(C) or six days(D) a week for periods of sixty days. Sampling time of 90 days was one month after garlic removal from the diet.

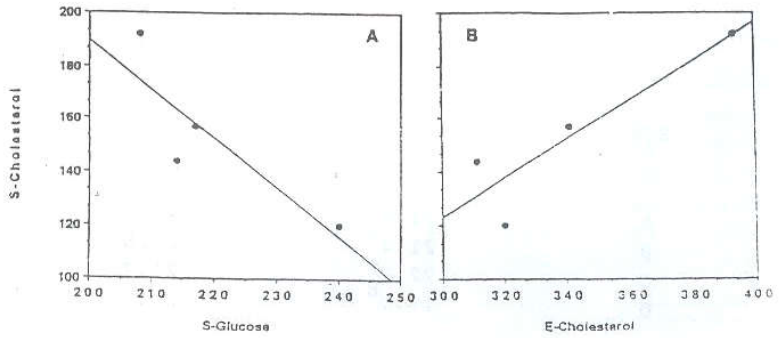

Fig. 2. Relationship between serum(S-) cholesterol and S-Glucose(A) and S-cholesterol and egg yolk(E-) cholesterol(B) in laying hens fed a basic diet with different levels of garlic.

CONCLUSION

International awareness of the detrimental effects of high cholesterol level in human diets evolves low cholesterol in animal products as a scientific goal of practical values. Due to the accumulative evidence which indicates that some active ingredients in garlic readily react with sulfhydryl groups in chemical mediators, it was hypothesized that garlic feeding to laying hens may affect cholesterol metabolism in the desired direction, both to the birds and the consumer of their products. Fortunately, feeding garlic at palatable levels to laying hens was found to decrease egg cholesterol by more than 20%. Interestingly, the effect of garlic on cholesterol deposition seemed to be reversible and had no effects on the quantitative productivity of treated birds. This may indirectly indicate that garlic affects the regulation and metabolism of cholesterol within the physiological levels regulated for a normal function of embryogenesis. This is considered to be the first record for the negative effect of garlic on egg cholesterol. Work is in progress to test for whether eggs with garlic flavor are acceptable to the Egyptian consumer. More important is to test for the maternal effect of garlic feeding on egg hatchability in the next generation.

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تاثير الثوم على كمية ونوعية الانتاج فى الدجاج البياض

مريم الديب

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تم دراسة تاثير تغذية عليقة الذرة – فول الصويا المزودة بالثوم على دجاج البياض. استخدم دجاج Hy-Line عند عمر النضج الجنسى ووزع عشوائيا على احدى العلائق المضاف اليها الثوم الطازج المفروم فى معاملات كالاتى: ٥ جم ثوم/ دجاجة/يوم لمدة يوم واحد بالاسبوع (معاملة ب) ، لمدة ٣ ايام بالاسبوع (معاملة س) او لمدة ٦ ايام فى الاسبوع (معاملة د). تم مقارنة الدجاج المعامل بمجموعة دجاج غير معملة (الكونترول) (معاملة ا).

اكدت النتائج ان اضافة الثوم خفض الكولسيترول فى صفار البيض معنويا. ولكن هذا التاثير لم يكن واضح خلال ١٥ يوم الاولى من التجربة. بينما ادى زالة الثوم من العليقة الى إرتفاع الكلوليسترول فى بيض الدجاج المعامل الى نفس المستوى فى بيض الدجاج الغير معامل . لم يلاحظ اى فروق معنوية على وزن الجسم ، الاحشاء المأكولة (الكبد – القلب– القونصة)، وزن الامعاء أو وزن الدهن فى تجويف الامعاء نتيجة للتغذية على الثوم. تم قياس كتلة البيض وجودة البيض على فترات كل ١٥ يوم. ازدادت كتلة معنويا فى المعاملة (د) بينما نتائج سمك القشرة وجودة البيض لم تكن منتظمة لعوامل اخرى غير المعاملة بالثوم لم يكن هناك إختلافات فى معدل التحويل الغذائى أو متوسط وزن البيض. معامل الإرتباط لم يكن معنوي بالنسة لمستوى الدم من الكوليسترول والجلوكوز وكانت متلازمة مع مستوى الثوم بالعليقة. ايضا معامل الارتباط بين كوليسترول البيض وكوليسترول الدم كان معنوى (ر=٠,٩٥).