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A Comparative Study between the Effects of Feed Inclusion with Garlic (*Allium sativum*), Cloves and Turmeric (*Curcuma longa*) Rhizome Powder on Laying Hens' Performance and Egg Quality

Research Article

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ABSTRACT

This experiment was conducted, during a seven-week period to investigate, the effects of using various levels of garlic cloves and turmeric rhizome powders, on laying hens' performance, egg quality characteristics and cholesterol content in yolk. Two hundred and sixteen, 27-weeks old Novogen white laying hens were assigned randomly into nine treatments with eight replicates of three birds each. They were fed diets with 0, 0.5, 1, 1.5 and 2% of garlic cloves' or turmeric rhizome powder. Data of layer performance, egg quality were collected, and total cholesterol content in egg yolk was measured in eggs. Final live body weight, daily feed intake and feed conversion ratio were not affected by the diets supplemented with garlic cloves' and turmeric rhizome powder (P≥0.237). No significant differences were detected in egg production, shell-less eggs' rate and egg weight (P≥0.375). However, addition of 2% garlic cloves' powder reduced broken eggs' rate (P=0.030). Supplementation of garlic cloves' and turmeric rhizome powder had a significant effect (P<0.0001) on double yolk eggs rate. Albumen weight, diameter and height were also influenced by garlic cloves' and turmeric rhizome powder addition (P≤0.007). Egg shell weight was heavier in turmeric 1% hens' group (5.64 g) than control and garlic 0.5% groups. Feed inclusion of 1% garlic cloves' and turmeric rhizome powder decreased egg yolk cholesterol concentration (P=0.024). In conclusion, feed addition of garlic cloves' and turmeric rhizome powder can be used as alternatives to improve egg quality in laying hens.

KEY WORDS albumen, cholesterol, garlic, laying hen, turmeric, yolk.

INTRODUCTION

Garlic (*Allium sativum*) and turmeric (*Curcuma longa*) are used as natural cholesterol-lowering feed agents. Their beneficial properties on health are widely studied according to Shukla and Singh (2007). Some phenolic components in these plants have antioxidative and anti-inflammatory activities. During the two last decades, efficiency of garlic on human health was largely proven in many clinical reports including meta-analysis, especially in lowering-cholesterol (Warshafsky *et al.* 1993; Neil *et al.* 1996). Furthermore, recent studies showed that «herbal enriched super eggs» can be obtained from laying hens fed with concentrates supplemented with phytobiotics, herbs containing secondary metabolites such as garlic, onion, spirulina, basil leaves, turmeric powder, citrus pulp, flaxseed (Canogullari *et al.* 2009; Damaziak *et al.* 2017; Kirubakaran *et al.* 2011; Holman and Malau Aduli, 2012; Mirbod *et al.* 2017; Nazok *et al.* 2009; Hassan, 2016; Ehr *et al.* 2017). They have also immuno-moderator, antioxidant properties and polyunsaturated fatty acids (omega 3). Moreover, super eggs have higher vitamin E contents (90-100 µg/g egg yolk) *vs.* (220-240 µg/g egg yolk) than standard eggs (Dominic *et al.* 2014). Thus, to obtain functional beneficial feeds for human health, different notions have been developed such as "herbal enriched super egg". The present assay is conducted in this context. It aims to study the effects of garlic cloves' and turmeric rhizome powder on laying hen performance and egg characteristics.

MATERIALS AND METHODS

A total number of 216 twenty seven weeks old White Novogen laying hens were randomly allotted into nine groups with eight replications of three birds each. Nine feeds were prepared for each group for an experimental duration of seven weeks. Laying hens feed composition is illustrated in Table 1.

Red garlic (GA) cloves and dry turmeric (TU) bulbs were obtained from a Tunisian local store. Garlic cloves were peeled and sliced thinly. They were dried during seven days at 40 ˚C in a ventilated oven. Dry turmeric bulb and garlic slices were grinded separately into powder, then mixed in laying hens' feeds. Diets were supplemented with garlic and turmeric powders with 0 (control), 0.5, 1.0, 1.5 and 2% levels (Table 2) and each diet was assigned randomly to a group of eight replicates with three laying hens each. Feed and water were provided *ad-libitum*, and birds were under a lightening program set at 16L/8D. The assay was conducted according the recommendations of Animal Care and Use Committee presented in Tunisian law number 2005-95 (18 October 2005) concerning animal breeding.

Measures

Laying performance

Laying hens were individually weighed, at 27 and at 34 weeks old and feed intake and egg production was controlled weekly during the experimental period. Then daily feed intake (DFI; g/day/hen) feed conversion ratio (FCR; g/egg) and egg production intensity were calculated.

Egg quality characteristics

During the last four weeks of the experimental period, eight eggs were collected weekly from each treatment. Cracked, broken, shell-less and double yolk eggs rate were also registered weekly. Four eggs were randomly taken from each treatment every week. Each egg was weighed and its width and length were measured. Then, it was broken and yolk and albumen heights and diameters were recorded with tripod micrometer. Color intensity of fresh egg yolk was measured using the Roche Yolk Color Fan.

Another group of four eggs from each treatment was randomly taken weekly then cooked in boiling water for 45 minutes at 320 ˚C. After cooling, yolk, albumen and shell are carefully separated and weighed.

Cholesterol content analysis

At the end of the experimental period, eight eggs (one egg/per replicate), were randomly selected from each treatment to analyze total cholesterol in fresh yolks by using an enzymatic-colorimetric standard method (cholesterol enzymatic colorimetric test, Biomaghreb, Tunisia) on solubilized yolk samples in a 2% (w/v) NaCl solution.

Statistical analysis

Data were analyzed by analysis of variance, using ANOVA procedure of SAS (1989). Statistical differences among treatment means were determined through Duncan's multiple range tests and in all statistical analyses, $P < 0.05$ was considered significant.

Regressions between garlic and turmeric rate feed supplementation and mean values of albumen and shell weight, yolk intensity color or total yolk cholesterol content were established.

RESULTS AND DISCUSSION

Live body weight, egg production and daily feed intake

Initial and final live body weight (LBW), egg production rate, daily feed intake and feed conversion ratio, were not affected by garlic or turmeric supplementation ($P \geq 0.237$, Table 2). Initial and final LBW hens' were uniform ($P \geq 0.327$), for all groups (1463 g±0.008 and 1590 g±1.17, respectively). Mean DFI, FCR and egg production rate were 116.4 g, 138.8 g/egg and 84.76% (Table 2), respectively.

Canogullari *et al.* (2009) founded that 1% garlic supplementation gave heavier weight of hen compared to the 2% dose. They have also proved that a high dose (4%) of garlic causes a negative effect. Malekizadeh *et al.* (2012) reported that the final LBW of hens did not vary with the addition of ginger and turmeric. Gowda *et al.* (2008) reported that weight gain did not vary with 0.5% turmeric. These findings corroborate with those of Lim *et al.* (2006); who observed that there was no difference in feed intake and feed efficiency of laying hens fed garlic powder (0%, 1%, 3% and 5%). Azeke and Ekpo (2009) reported that garlic supplementation added at a rate of 1% did not affect the feed intake. According to Canogullari *et al.* (2009), garlic supplementation had no incidence on FCR and feed efficiency. Also, Reddy *et al.* (1991) confirmed that 0.02% of garlic powder feed supplementation, did not modify feed efficiency.

Table 1 Composition of laying hens feed

Feed ingredients	**%**
Maize	63.0
Soybean meal, 48%	25.0
Limestone	9.53
Dicalcium phosphate	1.82
NaCl	0.32
DL-methionine	0.08
Premix[1]	0.25
Calculated nutrient composition	
Metabolizable energy (ME) (kcal/kg)	2737
Crude protein (CP) (%)	16.23
Calcium (%)	3.93
Phosphorus (%)	0.61
Methionine	0.35
Methionine + cysteine (%)	0.64
Lysine	0.85

[1] Feeds provided also per kg of diet: Copper: 13.26 mg; Selenium: 0.21 mg; vitamin A (retinyl acetate): 12500 IU; vitamin D_3: (cholecalciferol): 2000 IU and vitamin E (DL-α-tocopherol acetate): 15 mg/kg.

Table 2 Effect of garlic cloves' and turmeric rhizome powder supplementation on live body weight (LBW) (g), daily feed intake (g/day/hen), feed conversion ratio and egg production (%)

Treatment	Dose (%)	Initial LBW (g)	Final LBW (g)	Egg production (%)	Daily feed intake (g/day/hen)	Feed conversion ratio (g/egg)
Control	0.0	1460	1578	84.78	117.3	139.8
GA	0.5	1446	1592	85.20	115.2	136.0
	1.0	1468	1574	85.03	116.6	138.4
	1.5	1471	1600	85.03	116.6	138.4
	2.0	1456	1589	85.55	116.9	137.6
TU	0.5	1470	1579	84.91	117.4	140.0
	1.0	1474	1619	85.62	115.7	136.9
	1.5	1461	1590	82.74	115.8	141.1
	2.0	1466	1590	83.95	116.4	140.9
P-value		0.430	0.327	0.375	0.766	0.237
SEM		0.008	1.17	0.702	1.06	1.49

GA: garlic treatment and TU: turmeric treatment.
SEM: standard error of the means.

Nevertheless, Khan *et al.* (2008) showed that the incorporation of garlic powder (0%, 2%, 6%, and 8%) didn't affect feed intake. Malekizadeh *et al.* (2012) reported that feed efficiency did not vary with turmeric feed inclusion, while the addition of 1% of ginger increased feed intake. According to the same authors, ginger may have a stimulating effect on gastric, bile, pancreas and intestine juices, as well as improving antioxidant activity.

In contrast to our results on egg production, the highest egg production rate was obtained with 0.5% and 1% of garlic supplementation compared to those of 0% and 2% which are in accord with Canogullari *et al.* (2009). They explained that by the strong garlic odor which had a repulsive effect on feed intake. In contrast, Chowdhury *et al.* (2002) reported that egg production rate was not affected during six weeks of the experiment with the incorporation of 0%, 2%, 4%, 6%, 8% and 10%. On the other hand, Yalçin *et al.* (2006) observed that egg production did not change with garlic addition in the diet.

Egg quality characteristics

Statistical analyzes showed that garlic and turmeric feed inclusion at different doses influenced broken eggs' rate (P=0.030). Indeed no broken eggs were registered in GA 2.0 group. However, no effect was observed on shell-less eggs rate (P=0.383, Table 3).

In this study, garlic may improve shell strength and reduce breaking egg risks. Broken egg rate in turmeric hens was similar to those obtained for the control group. It is deduced that 2% of garlic powder is probably more effective than turmeric in reducing the risk of egg breakage.

Double yolk egg rate was the lowest for control (0.326%), while the highest values were recorded for GA0.5 (3.30%), TU0.5 (3.44%) and TU1.5 (3.12%), (P<0.0001, Table3). Beyond 0.5% of garlic feed inclusion, double yolk rate in GA (1.0, 1.5 and 2) was similar to those obtained for control birds.

Differences in double yolk egg rate were detected between treatments (P<0.0001, Table 3).

Table 3 Effect of garlic cloves' and turmeric rhizome powder supplementation on broken, shell-less and double yolk eggs' rates (%)

Treatment	Dose (%)	Cracked and broken egg rate (%)	Shell-less egg rate (%)	Double yolk egg rate (%)
Control	0.0	0.762[ab]	1.15	0.326[c]
GA	0.5	0.511[ab]	0.933	3.30[a]
	1.0	1.48[a]	1.48	1.12[bc]
	1.5	1.48[a]	1.48	1.12[bc]
	2.0	0.000[b]	0.95	1.16[bc]
TU	0.5	0.443[ab]	0.000	3.44[a]
	1.0	0.416[ab]	1.22	2.62[ab]
	1.5	1.20[ab]	1.20	3.12[a]
	2.0	1.58[a]	1.17	2.50[ab]
P-value		0.030	0.383	< 0.0001
SEM		0.382	0.403	0.604

GA: garlic treatment and TU: turmeric treatment.
The means within the same column with at least one common letter, do not have significant difference (P>0.05).
SEM: standard error of the means.

Hajiuon (2013) and Obochi *et al.* (2009) reported that garlic extract appears to stimulate the secretion of gonadotropins and ovarian hormones by activating the pituitary gland and the Golgi complex and improves the estrogen receptor binding capacity in female mice. In addition, Deshpandee *et al.* (1998) indicated that curcumin binds to diaryheptanoid estrogen receptors which generate similar benefits to estrogen. Thus, in our study, both turmeric and garlic may induce the stimulation of ovulation when they are added at 0.5% in laying hens diets. At higher dose, this effect is no longer detected.

Diet effect was significant for shell and albumen weight (P≤0.049, Table 4) and control group had the lightest shell (5.01 g) while TU1.0 showed the heaviest one (5.64 g).

Qatramiz (2006) suggested that garlic improved egg shell and egg quality. Our findings indicated also, that shell weight mean values were more correlated with the garlic than turmeric supplementation rate in feeds (r^2=0.980 and P=0.02 *vs.* r^2=0.944 and P=0.299). Thus, it increased from (5.01 g) in control birds to (5.30 g) in GA (0.5) lot, then to a maximum point (5.45 g) corresponding to 1% of GA in the diet. Beyond this supplementation dose, a slight decrease was observed in GA (1.5) and GA (2.), corresponding to (5.41 g) and (5.36 g). This global tendency was also detected with turmeric feed inclusion, however regression coefficient was lower (r^2=0.689). Indeed, shell weight increased with turmeric supplementation until a threshold 1% which corresponded to the peak (5.64 g). Beyond this dose, shell weight decreased to 5.34 for TU 1.5, and then increased slightly in TU 2.0 to 5.45 g.

Albumen weight data showed that it is significantly affected (P=0.007, Table 4) by diets, and it decreased with 2% of garlic or turmeric rate in feeds, whereas the highest value was recorded in GA0.5 group (39.31). Similarly it was detected that there was a high polynomial regression between rate inclusion of turmeric in feeds and mean albumen weight values (r^2=0.982).

Similar regression was detected between turmeric supplementation and albumen weight, and the peak was obtained in TU1.0 (38.75 g). Beyond this rate, albumen weight decreased until reaching the lowest value (36.31 g) with 2% of turmeric in diet.

Furthermore, analogous trend was found between garlic rate incorporation and albumen weight. Nonetheless, this quadratic regression was less significant (r^2=0.997, P=0.055) and the peak was found in hens fed the diet containing 1% of garlic.

Mottaghitalab and Taraz (2004) showed that the supplementation of 0.5, 1 and 1.5% of garlic powder significantly decreases yolk weight. Moreover, Chowdhury *et al.* (2002) reported that yolk weight tor presented a quadratic variation curve with increasing levels of garlic. According to Azeke and Ekpo (2009), only 1% of garlic powder supplementation has resulted in a slight increase in yolk weight (+6%).

Similarly, they indicated a positive effect on the shell weight. Lokaewmanee *et al.* (2014) and Radwan *et al.* (2008) indicated that *Allium sativum* and *Curcuma longa* increased shell weight in eggs. In other studies garlic supplementation improved egg quality (Yalçin *et al.* 2006; Mahmoud *et al.* 2010) and albumen weight (Qatramiz, 2006; Mahmoud *et al.* 2010).

The mechanisms of garlic have been attributed to its effective antioxidant action (Yang *et al.* 1993), and its ability to stimulate immunological reactivity (Reeve *et al.* 1993). The same authors concluded that the addition of garlic probably reinforced the activities of pancreatic enzymes in hen and provided a microenvironment for better use of nutrients. This is what has been proved in rats by Ramakrishna *et al.* (2003).

Data in Table 4, showed that there was a significant effect on yolk height and albumen diameter (P≥0.026, Table 4).

Albumen diameter in collected eggs from TU0.5 and GA1.0 hens were lower than those found for the other lots.

Table 4 Effect of garlic cloves' and turmeric rhizome powder supplementation on egg characteristics

Treatment	Dose (%)	Egg weight (g)	Egg length (mm)	Egg width (mm)	Shell weight (g)	Albumen weight (g)	Yolk weight (g)	Albumen height (mm)	Yolk height (mm)	Albumen diameter (mm)	Yolk diameter (mm)	Yolk color intensity
Control	0.0	56.64^{ab}	57.34	43.13	5.01^{c}	36.88^{bc}	14.75	9.86	16.26^{c}	64.94^{ab}	37.62	7.313^{c}
GA	0.5	58.18^{ab}	56.10	43.01	5.30^{b}	39.31^{a}	13.56	8.58	17.20^{bc}	67.12^{a}	36.86	7.06^{c}
	1.0	56.72^{ab}	56.13	42.58	5.45^{ab}	37.75^{abc}	13.67	9.41	17.61^{ab}	61.23^{b}	36.60	7.44^{bc}
	1.5	57.35^{ab}	56.62	42.47	5.41^{ab}	37.50^{abc}	14.44	9.84	18.21^{ab}	64.04^{ab}	37.09	7.50^{bc}
	2.0	55.93^{b}	56.20	42.71	5.36^{ab}	36.38^{c}	14.19	9.67	18.05^{ab}	66.41^{a}	37.42	7.56^{bc}
TU	0.5	58.75^{a}	55.90	43.21	5.50^{ab}	38.56^{ab}	14.69	9.20	17.55^{ab}	61.61^{b}	37.21	7.81^{bc}
	1.0	59.07^{a}	56.72	42.86	5.64^{a}	38.75^{ab}	14.69	9.90	18.89^{a}	66.58^{a}	37.70	8.06^{bc}
	1.5	57.15^{ab}	56.67	43.46	5.34^{ab}	37.81^{abc}	14.00	10.58	18.27^{ab}	67.85^{a}	37.68	8.50^{ab}
	2.0	55.76^{b}	56.70	43.11	5.45^{ab}	36.31^{c}	14.00	10.48	18.63^{a}	64.94^{ab}	37.56	9.19^{a}
P-value		0.741	0.061	0.189	0.049	0.007	0.110	0.178	0.0002	0.026	0.896	0.0005
SEM		1.27	0.846	0.678	0.328	1.38	0.499	0.917	0.973	3.04	1.11	0.690

GA: garlic treatment and TU: turmeric treatment.
The means within the same column with at least one common letter, do not have significant difference (P>0.05).
SEM: standard error of the means.

However, larger albumen diameter was observed in TU1.5 (67.85 mm), GA0.5 (67.12 mm) and TU1.0 (66.41 mm), whereas yolk diameter was not modified by the diet.

Lokaewmanee *et al.* (2014) demonstrated that a dietary complex of garlic, red clover extracts and fermented wheat flour extracts with *Pantoea agglomerans* extract, developed the absorptive intestinal surface in duodenum and jejunum in laying hens which increased more digestion and enhanced more absorption of the available nutrients and improved egg quality.

Statistical analyses demonstrated as well, a significant effect of the diet on yolk color intensity (P=0.0005, Table 4). The lowest intensity color corresponded to the control and GA0.5 groups (7.31 and 7.06, respectively) and the most intense color was observed in TU2.0 (9.19).

Intensity of yolk color in eggs was linearly and positively correlated with the increase of turmeric dose (r^2=0.975, P=0.017), indicating the higher the rate of additional curcuma, the higher the intensity of the egg yolk index. Data ranged significantly between 7.31 in non-supplemented group to 9.19 in the group fed 2% of turmeric dose incorporation. Indeed, polynomial regression of third degree, in garlic lots was lower (r^2=0.8566, P=0.47) and yolk color of GA0.5 eggs was as low as in the control group. On the other hand, at 2% of rate, and compared to garlic, the incorporation of *Curcuma longa* showed more intense color (9.19 *vs.* 7.56).

Furthermore, our data proved that turmeric promoted deposit carotenoid pigment in egg yolk. Curcumin in turmeric is a diaylheptanoid, a natural phenol. Hence, turmeric powder had a higher impact than garlic and more the dose was higher the incidence was pronounced. This effect may possibly be due to a polyphenolic compound "the curcumin" which had medicinal properties that are quite interesting for both humans and poultry.

Al-Sultan (2003) reported that turmeric developed the immune system organs in the chicken and increased the number of white blood cells and red blood cells. In humans, curcumin is also an excellent antioxidant, anti-inflammatory and an anti-carcinogen molecule (Clauzure, 2007).

Nevertheless, Burgos-Morón *et al.* (2010), suggested in a recent review, that curcumin may cause toxicity, DNA damage, deficiency anemia or inhibition of specific drug metabolizing enzymes.

Total yolk cholesterol content

The incorporation of garlic and turmeric affected considerably total egg yolk cholesterol (P=0.024, Table 5). *Curcuma longa* 2.0% hens laid eggs with the highest total cholesterol in yolk (17.34%), whereas both groups of turmeric and garlic at 1% dose had lower rates. Therefore, 1% dose of garlic and turmeric powder gave the optimum result in this study and beyond it the total cholesterol in yolk increased again. The polynomial curves of second degree (Figures 1 and 2) illustrated clearly this variation within each lot. Overall, both treatments showed almost the same variation in total egg cholesterol, however, regression between garlic rate supplementation and main values of cholesterol content is higher (r^2=0.984 and P<0.016) than turmeric group regression (r^2=0.731 and P=0.269). Canogullari *et al.* (2009), Khan *et al.* (2007), Yalçin *et al.* (2006) and Chowdhury *et al.* (2002) reported that garlic supplementation powder significantly decreased the egg yolk cholesterol content. Azeke and Ekpo (2009), incorporated garlic and tea powder with different doses into laying hen feeds. They observed a significant reduction (P<0.05) in total cholesterol of egg yolk, low density lipoprotein (LDL), high density lipoprotein (HDL) and total triglycerides.

Table 5 Effects of treatments on total cholesterol in egg yolk

Treatment	Feed inclusion of garlic cloves' or tumeric rhizome powder (%)	Cholesterol in egg yolk (µg/g egg yolk)
Control	0.0	17.04[ab]
GA	0.5	16.15[abc]
	1.0	15.57[c]
	1.5	15.96[bc]
	2.0	16.49[abc]
TU	0.5	16.57[abc]
	1.0	15.72[c]
	1.5	16.20[abc]
	2.0	17.34[a]
P-value		0.0242
SEM		0.253

GA: garlic treatment and TU: turmeric treatment.
The means within the same column with at least one common letter, do not have significant difference (P>0.05).
SEM: standard error of the means.

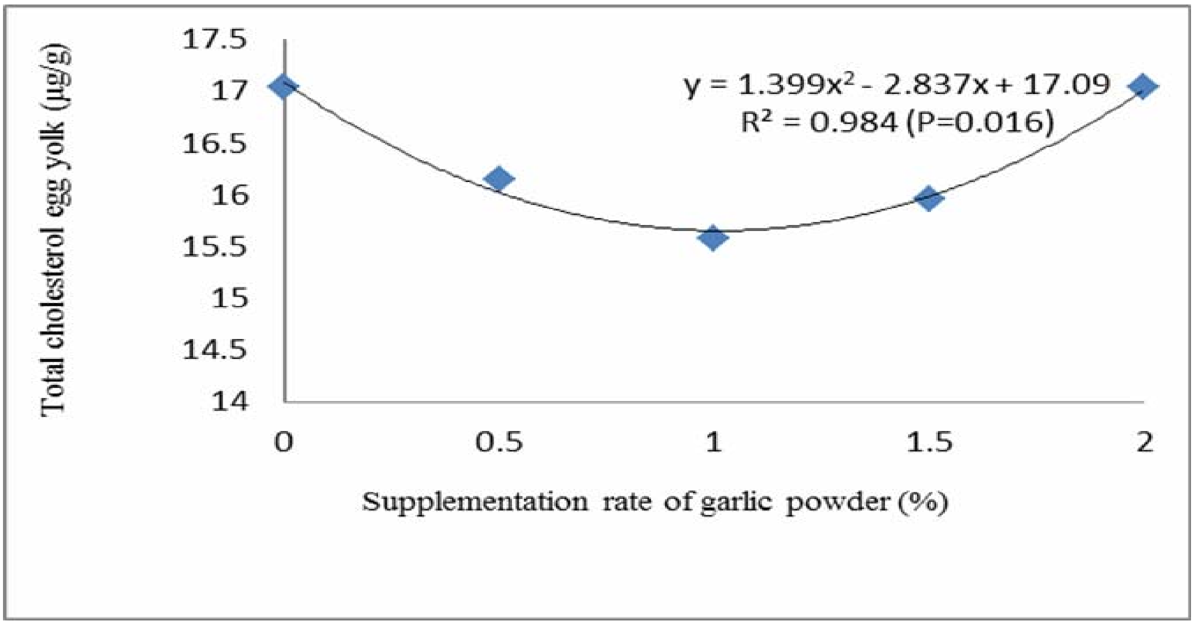

Figure 1 Effect of garlic cloves' powder supplementation on total cholesterol egg

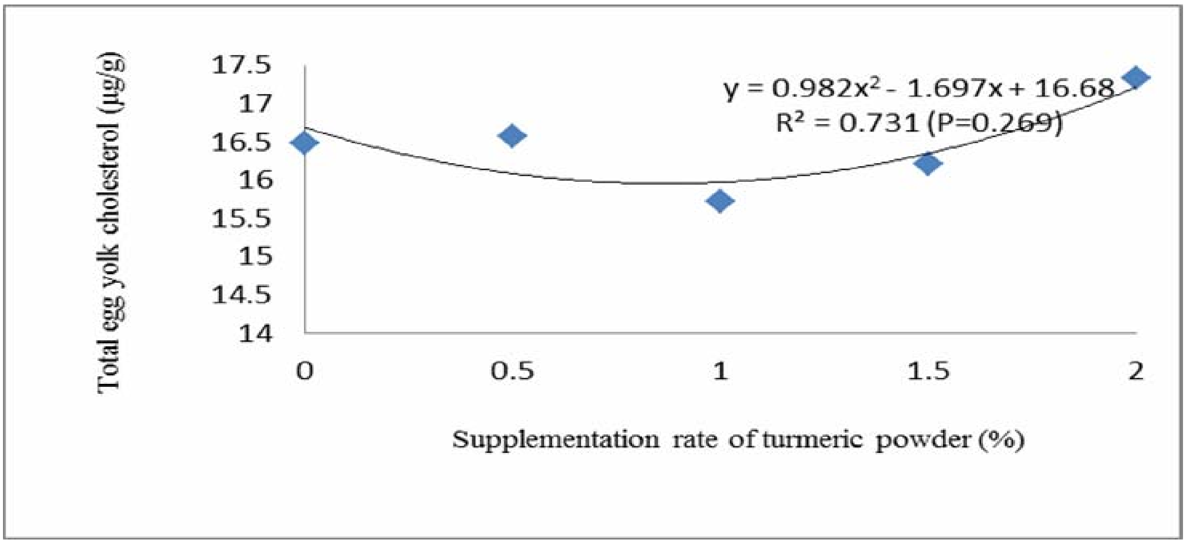

Figure 2 Effect of turmeric rhizome powder supplementation on total cholesterol egg

The exception was with the tea diet supplement with a 1% dose that resulted in a significant increase in the concentration of LDL cholesterol. They explained that anti-cholesterolemic agents found in garlic and flavonoid tea can be responsible for reducing the cholesterol content of egg yolk. Many researches proved clinically the cholesterol-lowering effect of garlic in blood plasma. Indeed, the results of meta-analysis of the controlled trials of garlic showed a significant reduction in total cholesterol levels (Warshafsky *et al.* 1993).

Garlic preparations are often designed to release allicin from the alline after consumption. It appears that the enzyme denaturated allinase rapidly at a low gastric pH (Ackermann *et al.* 2001). Flavonoids of green and black tea, when added directly to isolate LDL, protect against free radical induced lipid peroxidation. There is substantial evidence that oxidized LDL is one of the factors that led to atherosclerosis (Riemersma *et al.* 2001). Tea is an important source of phenols. Tea polyphenols, catechins and flavonols trap reactive oxygen species (Rice-Evans *et al.* 1996).

The ways and means by which these mechanisms lead to a reduction in cholesterol levels in egg yolk can be further investigated. The results of the reported study, however, showed that garlic and tea have great potential to reduce egg cholesterol at desired rates in the diet. In our cholesterol data it is proved that hens are more sensitive to 1% garlic and turmeric supplementation. Yalçin *et al.* (2006) suggested that the allicin, which causes the smell of garlic, was one of the main components rich in sulfur in garlic that can contribute to lowering cholesterol in plasma. Animal studies have suggested as well, that the garlic diet can inhibit the synthesis of cholesterol and fatty acids in the liver (Yeh and Liu, 2001). In this context, Malekizadeh *et al.* (2012) founded that turmeric affected significantly ($P<0.05$), the total cholesterol. Supplementation with ginger powder (1% and 3%) reduced cholesterol compared to the control diet. While the diet supplemented with turmeric powder (1%) significantly reduced the total cholesterol more than ginger.

Kermanshahi and Riasi (2006) reported that turmeric powder (0.05, 0.10, 0.15 and 0.20) in laying hens decreased serum triglycerides, total cholesterol and LDL cholesterol. They concluded that turmeric dietary supplementation improves certain indices of serum blood components that can be applied to manipulate the yolk composition.

Fuhrman *et al.* (2000) have suggested that polyphenolic flavonoids of ginger can prevent atherosclerosis disease associated with a reduction in the plasma levels and in the plasma cholesterol concentration where by inhibiting the LDL oxidation.

On the other hand, Miquel *et al.* (2002) concluded that the anti-oxidant effect of turmeric could be particularly useful as an anti-atherogenic and in the management of cardiovascular diseases in which atherosclerosis is the most important factor. However, Banerjee and Maulik (2002), reported that other studies showed no cholesterol, nor blood pressure lowering effects and no fibrinolytic activity of garlic powder in human.

CONCLUSION

The supplementation of garlic and turmeric powder showed an increase in double yolk egg rates especially for the turmeric diet. Garlic incorporated at 2% reduced the rate of broken eggs. Also, they had beneficial effect on shell and albumen weight. Yolk color was more intense in the eggs of the groups receiving turmeric and some indicators of egg freshness (yolk height and albumen diameter) were improved and dietary supplementation of 1% of garlic and turmeric seems to decrease total yolk cholesterol. Even though, more experimental trials are needed to know the antioxidant effects and the nutritive composition of these eggs, especially LDL and HDL, saturated and unsaturated fatty acids especially omega 6 and omega 3 variation in egg yolk, to conclude whether garlic and turmeric powders give a “Designer egg”.

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