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Full Length Research Paper

Production performance, egg quality and some serum metabolites of older commercial laying hens fed different levels of turmeric rhizome (*Curcuma longa*) powder

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This experiment was conducted to evaluate the effects of different levels of turmeric rhizome powder (TRP) on production performance, egg quality and some serum metabolites of older laying hens. A total of 240 hens (Hy-Line W-36) in their second laying cycle were randomly assigned to 5 dietary treatments (basal diet supplemented with 0.0, 0.5, 1, 1.5, and 2 g kg^{-1} TRP) with 12 replicates and 4 birds each. Results showed that 2 g kg^{-1} of TRP decreased ($P<0.05$) the feed conversion ratio (FCR). Adding TRP to the diet had no significant effect on egg specific gravity, egg shell thickness, egg shell weight and egg shell weight to egg weight ratio. However, the supplementation increased ($P<0.05$) yolk color fan value after 4 weeks. The diets supplemented with 0.5 to 2 g kg^{-1} of TRP markedly decreased ($P<0.05$) serum triglyceride, total and LDL-cholesterol just two weeks after starting the experiment. It was concluded that TRP, at the level of 2 g kg^{-1}, had strong potential for changing the serum lipid profile and improvement of FCR in older laying hens.

Key words: Turmeric, egg quality, blood metabolites, production performance, laying hens.

INTRODUCTION

Pullet replacement is one of the most expensive costs in the commercial egg industry. The farmers prefer to keep the hens for an additional laying cycle, when pullet replacing is expensive (Bell, 2003). In older laying hens preservation of ideal egg production is difficult and these birds are more susceptible to some metabolic disorders such as fatty liver (Squires and Wu, 1992).

Turmeric (*Curcuma longa*) is a perennial herb that grows and cultivated extensively in the tropical regions of Asia and Central America. The yellowish rhizome powder of this plant is traditionally used as a spice and food coloring agent. The main essential oils obtained from rhizomes are zingiberene (25%) and sesquiterpines (53%) (Chattopadhyay et al., 2004). Turmeric is well known for its medical values and has been a recipe for the treatment of many diseases (Srimal, 1997). Fortunately, the safety of turmeric and its yellow coloring agents are approved by many organizations and researchers (Hallagan et al., 1995; Srinivasan, 2005). Curcumin (diferuloylmethane), the main yellow bioactive component of turmeric, has been indicated to have wide biological actions. Some of its biological effects are hypolipidaemic (Srimal, 1997), hepatoprotective (Kiso et al., 1983), antioxidant (Gowda et al., 2008; Yarru et al., 2009), anti-inflammatory and antiarthritic (Chandra and Gupta, 1972), antiplatelet (Srivastav et al., 1995), hypoglycaemic (Chattopadhyay et al., 2004) and vasodilator (Sasaki et al., 2003). The partial protective effects of turmeric (*C. longa*) powder on expression of

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antioxidant, biotransformation and immune system genes in liver of broiler chicks has been demonstrated by Yarru et al. (2009). There are limited studies on the effects of turmeric powder supplementation in birds, specially laying hens (Radwan et al., 2008). Therefore, the purpose of this study was to evaluate the effect of diets supplemented with different levels of turmeric rhizome powder (TRP) on production performance, egg quality and some serum metabolites of hens in their second laying cycle.

MATERIALS AND METHODS

Two hundred and forty laying hens (Hy-Line W-36, 100 weeks age) at peak of production, during the second laying cycle, were randomly assigned to 5 treatments (basal diet supplemented with 0.0, 0.5, 1.0, 1.5, and 2.0 g kg^{-1} TRP) in a four weeks period. The treatments had 12 replicates and 4 birds in each replicate. All the birds were housed in clean steel cages and subjected to standard routine management. The basal diet was formulated to meet the requirement of laying hens as recommended by Hy-line, W-36 manual (Table 1). Number of eggs and eggs weight were recorded daily throughout the experiment. Feed consumption, egg mass and feed conversion ratio (FCR) were recorded weekly. Specific gravity of eggs, shell thickness, shell weight, egg weight and yolk color value were measured every two weeks in two eggs of each replicate. Specific gravity of eggs was determined by using the saline flotation method (Hempe et al., 1988) and yolk color fan value was measured using Roche yolk fan color. At the end of experiment, blood samples from the brachial vein of two hens in each replicate, were collected and centrifuged (3000 × g for 15 min) after coagulation. Then, some serum metabolites including triglyceride, total cholesterol, LDL-cholesterol and HDL-cholesterol were measured using appropriate laboratory kits (Friedewald et al., 1972; Gordon and Amer, 1977). All data were analyzed in a completely randomized design by the GLM procedure of SAS software (SAS Institute, 2001). The following model was assumed in the analysis of all studied traits:

$$Y_{ij} = \mu + A_i + e_{ij},$$

Where Y_{ij} = observed value for a particular character; μ = overall mean; A_i = effect of the $_i$th treatment and e_{ij} = random error associated with the $_{ij}$th recording. Least squares method was used to identify the significant differences between experimental groups at the 0.05 significance levels. Effect of sampling time and time × treatment interaction were calculated using repeated measurement analysis (SAS, 2001).

RESULTS AND DISCUSSION

Production performance

Effects of TRP on production performance of laying hens are shown in Table 2. Supplementation of TRP had a slightly effect on feed intake during the weeks 1 to 3, however, in week 4, the significant effect (P<0.05) was observed. Overall, hens fed diets containing 1.5 and 2 g kg^{-1} of TRP had lower feed intake than those the other groups. Radwan et al. (2008) who used 5 and 10 g kg^{-1} TRP in diets of laying hen reported that the feed intake numerically increased. This discrepancy could be due to the higher levels of TRP in the previous study and the probably effects of turmeric aroma on birds' appetite. Different levels of TRP had no effect on egg mass production in separate weeks, however 2 g kg^{-1} TRP significantly (P<0.05) increased egg mass production over the 4 weeks assay.

Feed conversion ratio was affected by TRP supplementation after just 2 weeks post starting the experiment. Diet containing 2 g kg^{-1} TRP showed the lowest FCR in weeks 2, 3, 4 and 1 to 4. This effect was mainly due to decreased feed intake and increased egg mass production. Usually, in older laying hens preservation of ideal egg production is difficult and the manipulation of diets for better FCR is very important. Our finding indicated that TRP at level of 2 g kg^{-1} had beneficial effects on egg mass production and improved FCR. Our observation was in consistent with the finding of Radwan et al. (2008) who tested the higher levels (5 and 10 g kg^{-1}) of TRP in laying hens' diet. They demonstrated that the improved production performance may be attributed to the antioxidant activity of turmeric (Gowda et al., 2008; Yarru et al., 2009). On the other hand, Zainali et al. (2008) reported that 5 and 10 g kg^{-1} of TRP had a positive effect on weight gain of broiler chickens reared under heat stress condition. There are some reports for the effect of TRP on elevation of intestinal lipase, sucrase and maltase activity (Platel and Srinivasan, 1996) and/or the activity of pancreatic lipase, amylase, trypsin and chymotrypsin enzymes (Platel and Srinivasan, 2000). Therefore, the positive effects of TRP on older laying hen performance was probably related to its antioxidants characteristics and stimulating the intestinal secretions.

Egg quality

Some egg quality traits are presented in Table 3. In consistent with Radwan et al. (2008), our results showed that different levels of TRP had no significant effect on egg shell thickness and egg shell weight. Radwan et al. (2008) reported that the higher levels of turmeric (5 and 10 g kg^{-1}) may improve the small environment of uterus and consequently increase the shell weight and shell thickness. In the present study specific gravity and egg shell weight: egg weight was not affected by TRP levels.
Supplementation of TRP had no effect on yolk color fan value after two weeks of experiment, but its effect was remarkable after 4 weeks. Levels of 1 and 2 g kg^{-1} TRP had higher (P<0.05) yolk color fan value compared with the control group. The yellowish pigment of turmeric (curcuminoids, curcumin and its related compounds) may be responsible for slightly improving the yolk color. Awang et al. (1992) who used curcumin for upgrading skin color of broilers reported that this pigment was deposited in the broiler skin.

Table 1. The composition and nutrient content of basal diet fed to the laying hens.

Item	Amount
Ingredients (g kg^{-1})	
Wheat	635.5
Soybean meal	187.0
Animal-vegetable fat blend	44.1
Oyster shell	113.3
Dicalcium phosphate	9.0
Common salt	3.1
DL-Methionine	0.6
L-Lysine	0.4
Fine grit[1]	2.0
Vitamin and mineral premix[2]	5.0
Calculated analysis	
ME (kcal/kg)	2700
Crude protein (g kg^{-1})	150.0
Calcium (g kg^{-1})	40.0
Available phosphorus (g kg^{-1})	3.0
Linoleic acid (g kg^{-1})	11.0
Methionine + Cysteine (g kg^{-1})	5.4
Lysine (g kg^{-1})	7.4
Tryptophan (g kg^{-1})	2.1
Arginine (g kg^{-1})	8.4

[1]Fine grit was replaced with 0.0, 0.5, 1, 1.5, and 2 g of TRP as treatments. [2]Vitamin and mineral premix provided per kilogram of diet: vitamin A, 10000 IU; vitamin D3, 2500 IU; vitamin E, 10 IU; vitamin B1, 2.2 mg; vitamin B2, 4 mg; pantothenic acid, 8 mg; vitamin B6, 2 mg; niacin, 30 mg; vitamin B12, 0.015 mg; folic acid, 0.5 mg; biotin, 0.15 mg; cholin chloride, 200 mg; manganese, 80 mg; copper, 10 mg; iodine, 0.8 mg; cobalt, 0.25 mg; selenium, 0.3 mg; zinc, 80 mg; iron, 80 mg.

Table 2. Effect of turmeric rhizome powder (TRP) on production performance of laying hens.

Production performance	Dietary levels of TRP (g kg^{-1})					
	0.0	0.5	1	1.5	2	S.E.M
Feed intake (g/hen)						
Week 1	726	713	731	702	716	20.1
Week 2	739	739	706	713	703	26.3
Week 3	727	716	721	694	697	31.5
Week 4	704^{a}	669^{b}	680^{ab}	655^{b}	634^{b}	20.2
Weeks 1 – 4	2896^{a}	2837^{a}	2838^{a}	2764^{b}	2750^{b}	27.6
Egg mass (g/hen)						
Week 1	300.0	292.2	288.9	280.1	307.3	18.3
Week 2	294.4	300.4	279.1	259.3	309.7	23.1
Week 3	279.6	304.7	297.9	259.9	314.0	22.5
Week 4	267.7	282.3	283.3	254.9	293.5	19.2

Table 2. Contd.

Weeks 1 - 4	1141.7[b]	1179.6[ab]	1149.2[b]	1054.2[b]	1224.5[a]	21.7
FCR[1]						
Week 1	2.42	2.44	2.53	2.50	2.33	0.17
Week 2	2.51[ab]	2.46[bc]	2.53[ab]	2.75[a]	2.27[c]	0.12
Week 3	2.60[ab]	2.35[bc]	2.42[abc]	2.67[a]	2.22[c]	0.15
Week 4	2.63[a]	2.37[ab]	2.40[ab]	2.57[a]	2.16[b]	0.18
Weeks 1 - 4	2.54[a]	2.41[ab]	2.47[ab]	2.62[a]	2.25[b]	0.21

[1]FCR: Feed Conversion Ratio. [a–c] Means with no common superscript within each row are significantly (P < 0.05) different.

Table 3. Effect of turmeric rhizome powder (TRP) on egg quality traits of laying hens.

Egg quality	Dietary levels of TRP (g kg^{-1})					
	0.0	**0.5**	**1**	**1.5**	**2**	**S.E.M**
Specific gravity						
After 2 week	1.08	1.08	1.08	1.08	1.08	0.03
After 4 week	1.07	1.05	1.07	1.07	1.06	0.08
Egg shell thickness (mm)						
After 2 week	0.37	0.38	0.41	0.39	0.42	0.09
After 4 week	0.39	0.40	0.41	0.39	0.40	0.04
Egg shell weight (g)						
After 2 week	8.01	7.66	7.28	7.62	7.64	1.21
After 4 week	7.19	7.64	7.40	7.53	7.17	1.35
Egg shell weight: Egg weight						
After 2 week	0.125	0.119	0.111	0.122	0.123	0.010
After 4 week	0.131	0.120	0.131	0.122	0.127	0.018
Yolk color fan value						
After 2 week	3.50	3.62	3.56	3.44	3.69	0.21
After 4 week	3.55[b]	3.71[ab]	4.05[a]	3.88[ab]	3.99[a]	0.15

[a-b]Means with no common superscript within each row are significantly (P < 0.05) different.

Serum metabolites

Adding TRP to older laying hen diets affected their serum triglyceride, total cholesterol, HDL and LDL-cholesterol (Table 4). The birds in control group had the highest (P<0.05) triglyceride, total cholesterol, and LDL-cholesterol (3170, 323.5 and 251.9 mg dl^{-1}, respectively) and the lowest (P<0.05) HDL-cholesterol (23.3 mg dl^{-1}). Interestingly, there was no significant difference between the levels of 0.5, 1, 1.5 and 2 g kg^{-1} of TRP for changing the serum metabolites. Asai and Miyazawa (2001) reported that dietary curcuminoids decreased plasma triglyceride and total cholesterol in rats fed high fat diet. Turmeric has been evidenced in several animal studied to exert hypolipidemic and hypocholesterolemic properties (Srimal, 1997; Chattopadhyay et al., 2004; Srinivasan, 2005). These authors demonstrated an increase in hepatic cholesterol-7α-hydroxylase activity and a higher rate of cholesterol catabolism with curcumin. Therefore, our data suggested that TRP had strong

Table 4. Effect of turmeric rhizome powder (TRP) on some blood serum metabolites of laying hens.

Blood serum parameters(mg dl^{-1})	Dietary levels of TRP (g kg^{-1})					S.E.M
	0	0.5	1	1.5	2	
Triglyceride	3170^{a}	1371^{b}	1350^{b}	1297^{b}	1145^{b}	115.2
Total cholesterol	323.5^{a}	154.8^{b}	199.0^{b}	175.3^{b}	161.0^{b}	32.4
LDL-cholesterol	251.9^{a}	93.9^{b}	79.1^{b}	67.1^{b}	92.5^{b}	17.5
HDL-cholesterol	23.3^{c}	29.9^{ab}	33.0^{a}	33.8^{a}	26.9^{bc}	2.1

[a-c] Means with no common superscript within each row are significantly ($P < 0.05$) different.

potential for improving the serum lipid profile and it may be important for alteration the egg lipid profiles.

Conclusions

Our results suggested that TRP at level of 2 g kg^{-1} during 4 weeks experiment had beneficial effects on older laying hens, because it improved the FCR and may help to producers from economic aspects. Also, TRP as a plant origin coloring agent, had potential to improve the yolk color value of the eggs produced by older laying hens. Turmeric rhizome powder, with hypolipidemic and hypocholesterolemic properties, had strong effect for changing serum lipid profile and it bring the idea that TRP may affect on total cholesterol of eggs. Further studies must be carried out to test the protection effects of TRP on fatty liver syndrome, egg oxidation and the egg persistency.

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