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Submission date: 21-Jan-2020 03:02PM (UTC+0700)
Submission ID: 1244360874
File name: etabolism_and_its_effect_on_quality_of_the_first_quail_s_egg.pdf (84.84K)
Word count: 4521
Character count: 23307

THE ROLE OF TURMERIC POWDER IN LIPID METABOLISM AND ITS EFFECT ON QUALITY OF THE FIRST QUAIL'S EGG

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Received October 03, 2012; Accepted May 03, 2013

ABSTRAK

Penelitian ini bertujuan untuk mengetahui peran serbuk kunyit dalam metabolisme lipid dan pengaruhnya pada kualitas telur pertama burung puyuh. Eksperimen dirancang dengan menggunakan rancangan acak lengkap dengan 4 perlakuan kadar serbuk kunyit (0; 13,5; 27; dan 54 mg/ekor/hari) selama 60 hari. Masing-masing perlakuan menggunakan 3 ekor puyuh dan dilakukan pengulangan sebanyak 5 kali. Analisis proksimat dan kualitas telur dilakukan pada telur yang pertama kali dikeluarkan. Analisis kolesterol, trigliserida darah, bobot lemak abdominal dan pektoral, serta konsumsi pakan dilakukan pada akhir percobaan. Hasil penelitian menunjukkan bahwa serbuk kunyit mengandung kurkumin sebesar 7,97%. Pemberian serbuk kunyit menurunkan kadar kolesterol serum, trigliserida serum, lemak telur, dan meningkatkan protein telur, *haugh unit*, dan indeks kuning telur, tetapi tidak mempengaruhi konsumsi pakan, bobot lemak abdominal dan pektoral, bobot telur, bobot kerabang telur, tebal kerabang telur, dan indeks kerabang telur. Terjadi variasi penundaan waktu awal bertelur selama kurang lebih 2-16 hari pada puyuh yang diberi suplemen serbuk kunyit. Rata-rata hirarki folikel terbanyak ditemukanpada puyuh yang diberi serbuk kunyit kadar 54 mg/ekor/hari. Berdasarkan hasil penelitian dapat disimpulkan bahwa suplementasi serbuk kunyit dengan kadar 54 mg/ekor/hari merupakan kadar optimal dalam memperbaiki metabolisme lipid dan pendistribusiannya ke berbagai organ. Serbuk kunyit juga berperan dalam meningkatkan metabolisme protein dan kalsium pada burung puyuh sehingga dapat memperbaiki performans dan kualitas telur burung puyuh.

Kata kunci: Kurkumin, burung puyuh, metabolism lipid, kualitas telur

ABSTRACT

This experiment was conducted to determine the role of turmeric powder in lipid metabolism and its influence on the quality of the first quail's egg. Sixty female quails were assigned into a completely randomized design with four treatments (levels of turmeric powder i.e., 0; 13.5; 27; and 54 mg/quail/day) and each treatment used 15 quails. The treatment was conducted for 60 days. Parameters measured were proximate analysis and the quality of the first layed eggs. At the end of the experiment, serum cholesterol and triglyceride concentrations, abdominal and pectoral fat weights, and feed consumption were measured. Chemical analysis showed that turmeric powder contained 7.97% curcumin. Supplementation of turmeric powder lowered serum cholesterol and triglyceride concentrations, egg fat and protein contents, haugh unit and yolk index, but did not affect feed intake, abdominal and pectoral fat weights, egg weight, eggshell weight, eggshell thickness, and egg shell index. However, quails supplemented with turmeric powder showed a variation in egg laying delay ranging from 1 to 16 days. Quails supplemented with 54 mg/d turmeric powder had the highest follicles hierarchy. It was concluded that supplementation of turmeric powder with the level of 54 mg/quail/day decreased lipid content of the egg and improved the other egg quality parameters.

Keywords: curcumin, quail (Coturnixcoturnix japonica), lipid metabolism, egg quality

INTRODUCTION

Egg yolk is part of the egg which is a source of nutrients for the developing embryo. As a food, quail egg is a source of protein with a higher protein content (12.7%) than chicken egg, and fat

content is only 11.1% (Listyowati and Roospitasari, 1997; Rasyaf, 1998). Quail egg contains higher cholesterol as compared to other poultry eggs. In the eggs, cholesterol and its esters are primarily found in the yolk. Egg quality is a reflection of the chemical composition of the yolk. The quality of nutrition fed to the quail affect egg characteristics and quality, such as the size and proportions of the main content of the yolk and albumin (Watson, 2002).

Concern about cholesterol content has caused a lot of efforts to reduce the cholesterol content of quail eggs, including nutritional manipulation. Turmeric powder is a source of phytoestrogens from the class of isoflavones that could bind to estrogen receptor (Zava, 1998). The binding of phytoestrogens with estrogen receptor-related protein causes the synthesis of protein resulting in physiological responses (Levi *et al.*, 2009). Phytoestrogens in turmeric powder can stimulate liver cells to synthesize vitellogenin that finally increases vitellogenin deposition in the yolk. Vitellogenin is an egg yolk precursor. Continuous egg production after sexual maturity will increase liver activities and lead to changes in homeostasis that causes degeneration of the liver cell function. Curcumin is the active component of turmeric *(Curcuma Longa Linn)* and has biological and pharmacological activities (Chattopadhyay *et al*., 2004). Curcumin modulates and speeds up the process of repair or regeneration of liver cells (Thaloor, 1999). *Curcuma longa* root's crude extract at levels of 100 mg/kg body weight have a hepatoprotective effect and protect the integrity of the cell structure of paracetamol-induced rat liver (Somchit *et al*., 2005). Curcumin was also found to affect lipid metabolism, and inhibit lipid peroxidation (Kohli *et al*., 2005). Curcumin stimulates bile production which will be required in emulsification of lipid (Seo *et al*., 2008). Along with its effect on lipid metabolism in adipose cells, curcumin can reduce fat deposition and cause a lower body fat and this effect has a potential in preventing obesity. Mice fed a diet containing curcumin have lower serum cholesterol (Ejaz *et al*., 2011). Supplementation of turmeric powder is expected to improve liver metabolism and maximize vitellogenin synthesis. Vitellogeninis transported through the circulation to the developing follicles and deposited on the yolk. This experiment was designed to improve the quality of quail egg by decreasing fat and cholesterol contents.

MATERIALS AND METHODS

This study used turmeric powder (*Curcuma Long*a Linn) and day-old quail (*Coturnixcoturnix japonica*). The experimental quails were assigned into a Completely Randomized Design (CRD) with 4 treatments and 15 replications. The treatments were dosages of turmeric powder supplementation consisted of 0, 13.5, 27, and 54 mg/quail/day. Before treatment, a hundred of quails were acclimatized for two weeks in a collective cage and the coefficient of variability was calculated. After acclimatization period, 60 quails were selected and acclimatized one week in individual cages. Feed and drinking water were provided *ad libitum*. Turmeric powder supplementation was conducted at the age of 22 days to 60 days. Parameters measured were daily feed intake, blood cholesterol and triglycerides concentrations, pectoral and abdominal fat weights, and follicular hierarchy. Proximate analysis of the egg included fat, protein, cholesterol, ash, and water contents. Egg quality included egg weight, shell weight, shell thickness, diameter of egg yolk, egg yolk height, egg white height, egg yolk weight, egg white weight, egg yolk index, haugh index, and index of egg shell. The data obtained were analyzed by analysis of variance with SPSS procedure and Least Significant Difference test with significance level of 95%.

RESULTS AND DISCUSSION

The results showed that turmeric powder supplementation did not affect feed intake (Table 1). This results suggested that supplementation of turmeric powder containing 7.97% curcumin did not affect the palatability of ration. Increased feed intake was influenced by palatability of the feed and the levels of glucose in the blood. Curcumin has a similar effect on insulin that controls blood glucose homeostasis (Seo *et al*., 2008). Stable blood glucose levels does not stimulate excessive feed intake. The results showed that supplementation of turmeric powder improved lipid metabolism in quails. Cholesterol and triglycerides are lipids metabolized in the liver cells and distributed to various tissues.

Supplementation of turmeric powder with different levels in quails decreased serum cholesterol concentrations (Table 1). Serum cholesterol concentration in the control quails was 117.404 mg/dL. Supplementation of turmeric

Table 1. Feed Intake, Pectoral and Abdominal Fats, Serum Cholesterol and Triglycerides Concentrations in Quails Supplemented with Various Levels of Turmeric Powder

Parameter	Dose of Turmeric Powder (mg/quail/day)			
	0	13.5	27	54
Daily feed intake (g)	19.114	19.592	20.199	19.267
Serum cholesterol (mg/dL)	117.404[a]	109.626[ab]	106.500[b]	97.006[c]
Serum triglyceride (mg/dL)	115.426[a]	104.906[a]	93.942[b]	86.634[c]
Pectoral fat weight (g)	2.273	2.400	2.625	2.116
Abdominal fat weight (g)	2.301	2.907	3.233	2.379

Different superscripts in the same row indicates the significant differences (P<0.05)

powder at the level of 54 mg/quail/day decreased serum cholesterol concentrations by 17.3% to the concentration of 97.006 mg/dL.

Cholesterols in the blood were obtained from feed consumedor synthesized endogenously through a pathway present in virtually all cells in the body, especially the liver and intestinal cells. Regulatory mechanism maintains plasma cholesterol levels to remain constant, among others, through the efficiency of intestinal cholesterol absorption, adjustments in the level of cholesterol biosynthesis, the activity of LDL (Low Density Lipoprotein) receptor, the secretion of cholesterol into the bile, and the conversion of cholesterol into bile acids in the liver. Disturbance in the control of one or more of these processes will disturb the homeostasis of cholesterol.

Cholesterol is excreted by the liver via the bile into the digestive tract. Approximately 50% of the excreted cholesterol is reabsorbed by the intestine back into the blood stream. Cholesterol absorption is a complex process, in which cholesterol is required for the formation of micelles by bile acids in the intestinal lumen, and then taken up by enterocytes, assembled into lipoproteins, and transported into the circulation. Curcumin can disturb the reabsorption of cholesterol in the intestinal tract, thereby reducing the reabsorption of cholesterol. Niemann-Pick protein C1-Like 1 (NPC1L1) is a protein that was identified as a specific transporter for the absorption of cholesterol in the plasma membrane surface. Curcumin can lower serum cholesterol levels by inhibiting absorption through NPC1L1 transporter (Feng *et al*., 2010). Decrease in the reabsorption of bile acids cause a feedback mechanism so that a large amount of blood cholesterol was converted into bile acids that could lower cholesterol levels in the serum. Curcumin can stimulate the synthesis of LDL receptors (Emadi *et al*., 2007). Increase in LDL receptor causes the liver cells can take up more cholesterol from the body for the synthesis of bile acids, thereby causing a reduction in serum cholesterol. Curcumin inhibits 3-hydroxy-3-methylglutaryl-coenzyme A reductase as a key regulatory enzyme in cholesterol synthesis and consequently causes the hypocholesterolemic effects (Radwan *et al*., 2008). Cholesterol can not be oxydized in the body to be used as an energy source, so the way to lower blood cholesterol levels was by increasing excretion through bile acids. Curcumin in turmeric powder has an effect of increasing bile secretion. Bile consists of bile acids, bile salts, cholesterol, and phospholipids. Bile acid is synthesized in the liver. Cholesterol is the precursor for the bile acids synthesis. The process involves the conversion of cholesterol to cholic acid and acid chenodeoxycholate. The reaction is catalyzed by the enzyme 7α-hydroxylase. In the liver, bile acids conjugate with glycine or taurine which is a polar amino acid. The conjugates inhibit reabsorption of bile acids in the intestine and cause lipid degradation. Most of the primary bile acids in the intestine are changed by the activity of the intestinal that produce secondary bile acids. A growing number of primary bile acids that are degraded by intestinal bacteria cause the liver to synthesize new bile acids that uses cholesterol as a precursor. The results of turmeric powder supplementation with different levels in quail led to a decrease in serum triglyceride concentrations. Serum triglyceride concentration in the control quails

was 115.426 mg/dL. Supplementation of turmeric powder at dosage of 54 mg/quail/day decreased serum triglyceride concentrations by 24.94% to the level of 86.634 mg/dL.

Triglycerides are fats in that most efficient to store energy. During the period of growth, fat absorbed are widely used for energy needs. The first step of triglycerides for energy use is the hydrolysis of triglycerides into fatty acids and glycerol, then the result of hydrolysis is transported to the cells and oxydized to produce energy. Curcumin can be used as additives in growth stimulation (Sinaga *et al*., 2010). During growing period, energy requirement is increase so that blood triglyceride levels decrease. Curcumin can also increase the activity of lipoprotein lipase (Graham, 2009), which became one of the possible mechanisms of the effects of curcumin on the reduction of blood triglyceride concentrations. Turmeric powder also showed hypolipidemic effect by inhibiting the secretion of liver triglyceride (Chattopadhyayl *et al*., 2004).

The decreased serum concentrations of cholesterol and triglyceridewere also caused by the increased uptake by other tissues such as the adipose tissue and the ovarian follicle. The results showed an increase in abdominal fat accumulation in quail supplemented with turmeric powder (Table 1). Cholesterol and triglycerides are also component of the yolk protein or vitellogenin. Vitellogenin contains about 20% fat, mainly phospholipids, triglycerides, lipoprotein, and cholesterol, which are packaged in the form of VLDL (Very Low Density) and this VLDL has a half size of the normal VLDL and its surface binds to a polipoprotein VLDL-II. The small size allows this VLDL pass through the granulosa basal lamina of ovarian follicles and receptor binding of a polipoprotein B oolema. Through endocytosis, vitellogenin is deposited in egg yolks (Watson, 2002).

Ovarian follicles in quails supplemented with turmeric powder grew faster. Observation of follicular hierarchy at the first laying quails demonstrated that quails supplemented with turmeric powder at the level of 54 mg/quail/day had higher follicular hierarchy, despite the delay in laying. The delay in first time laying ranged at 1-16 days (Table 2). Follicular hierarchy was identified as gradation of follicle's diameter. F1 is follicle with the biggest diameter, followed by F2, F3, F4, F5, F6 and F7. Small follicles were classified according to diameter, as small yellow follicles, large white follicles, and small white follicles. The delay of the first laying time was partly due to the increased follicular hierarchy.

Turmeric powder also contains flavonoids that act as a phytoestrogen. The analysis showed that a flavonoid content of turmeric powder used in the experiment was 6.73%. Phytoestrogens have estrogen-like activity to induce the biosynthesis of vitellogenin. Phytoestrogens stimulates hepatocytes to synthesize vitellogenin that will be transported to the ovary through circulation as yolk precursors. In the ovary, phytoestrogens can stimulate the proliferation of follicular development that will increase the number of hierarchical follicles. In this experiment, it was shown that quails supplemented with turmeric powder had higher follicular hierarchy as compared to control quails.

The results of the experiment showed that turmeric powder supplementation improved the quality of eggs. The higher levels of turmeric powder supplementation decreased cholesterol and fat contents in quail eggs. Decreased levels of cholesterol and fat in the eggs quails supplemented with turmeric powder in part might be due to the increased number of developing follicles. With the greater number of developing follicles, cholesterol and fat as the main component of the yolk will be distributed to a greater number of growing follicles, so that the content of cholesterol and fat in each egg will be low. It can be seen Table 3, average cholesterol level in the control quail egg was at 1030.6 mg/dL and the cholesterol level was decreased by 11.15% to 915.707 mg/dL in the eggs of quails supplemented with turmeric powder at the dose of 54 mg/quail/day. The average fat concentration in the control quail eggs was 12.587 mg/dL and decreased by 10.76% to 11.233 mg/dL in the quail supplemented with turmeric powder with a dose of 54 mg/quail/day. However, turmeric powder supplementation improved protein concentrations in the egg. Egg protein is a combination of protein contained in egg yolk and albumen. Albumen is a protein which is synthesized, excreted, and accumulated in the epithelial cells and tubular gland cells in the magnum of the reproductive tract.

Curcumin in turmeric powder plays a role in inducing an increase in protein synthesis. The average egg protein content in the control quail was 12.573 mg/dL and this level increased by 4.27% to 13.11 mg/dL in the eggs of quails supplemented with turmeric powder at dosage of 54 mg/quail/day. Ash and water contents of the

Table 2. Hierarchy of Ovarian Follicles in the Quail Supplemented with Turmeric Powder from Age 22 Days until the First Spawn

Treatment	Age of the first spawn (days)	Delay of the spawn (days)	Follicular Hierarchy							Note
			F1	F2	F3	F4	F5	F6	F7	
P0-1-2	49	4	1.746	1.417	1.073	0.989	0.614			Spawn
P0-1-3			1.124	0.650						not spawn yet
P0-2-1	47	2	1.716	1.528	1.063	0.960	0.540			spawn
P0-2-1			1.178	0.720	0.620					not spawn yet
P0-3-3	45	0	1.621	1.375	1.165	0.663				spawn
P0-4-1	45	0	1.438	1.222	1.223	0.848				spawn
P0-5-1	57	12	1.724	1.464	1.322	1.157	0.750			spawn
P0-5-3			1.132	0.878						not spawn yet
P1-1-1	49	4	1.758	1.631	1.254	1.04	0.71	0.526		spawn
P1-1-2	49	4	1.391	1.280	0.914	0.758	0.417			spawn
P1-1-3			0.344	0.318						not spawn yet
P1-3-1			0.958	0.888	0.571					not spawn yet
P1-3-2	55	10	1.752	1.616	1.448	1.122	0.633	0.344		spawn
P1-3-3			1.263	0.977	o.882	0.55				not spawn yet
P1-4-1	53	8	1.597	1.385	1.249	0.957	0.580	0.357		spawn
P1-5-1	60	15	1.174	1.025	0.655	0.462	0.399	0.305		spawn
P1-5-2	60	15	1.270	1.180	1.037	0.673	0.388	0.270		spawn
P2-1-1	59	14	1.522	1.436	0.976	0.432				spawn
P2-2-1	49	4	1.476	1.078	0.545	0.402				spawn
P2-2-2	49	4	1.727	1.263	0.831	0.519	0.369			spawn
P2-3-1	46	1	1.218	0.650	0.590	0.414				spawn
P2-3-3			1.176	0.540						not spawn yet
P2-4-1	58	13	1.479	1.424	0.962	0.624	0.496			spawn
P2-5-1	55	10	1.712	1.324	1.179	0.685	0.449			spawn
P2-5-3	55	10	1.531	1.388	1.188	0.705	0.694	0.370		spawn
P3-1-1	50	5	2.119	1.551	1.480	1.251	0.886	0.570		spawn
P3-1-2			1.302	0.956	0.460					not spawn yet
P3-2-1	61	16	1.347	1.351	1.044	0.771	0.548	0.348		spawn
P3-2-2	61	16	1.529	1.313	1.174	0.964	0.691	0.568	0.396	spawn
P3-2-3			0.54	0.483						not spawn yet
P3-3-2			1.554	1.178	0.598					not spawn yet
P3-3-3	57	12	1.769	1.458	1.244	0.890	0.460			spawn
P3-4-2	52	7	1.601	1.458	1.288	0.765	0.419	0.305		spawn
P3-5-1	54	9	1.584	1.363	1.199	0.955	0.773	0.409		spawn
P3-5-2			1.298	0.799	0.432					not spawn yet

P0-1-2: Control, 1st experiment, 2nd repetition; P1-1-1: Tumeric powder with dosage of 13.5 mg/quail/day, 1st experiment, 1st repetition; P2-1-1: Tumeric powder with dosage of 27 mg/quail/day, 1st experiment, 1st repetition; Tumeric powder with dosage of 13.5 mg/quail/day, 1st experiment, 1st repetition

Table 3. Proximate Analysis of the First Layed Egg of Quail Supplemented with Various Dosages of Nurmeric Powder Supplementation

Parameters	Doses of Turmeric Powder (mg/quail/day)			
	0	13.5	27	54
Fat (mg/dL)	12.587[a]	11.920[b]	11.546[c]	11.233[d]
Protein (mg/dL)	12.573[a]	13.027[b]	13.123[b]	13.110[b]
Cholesterol (mg/dL)	1030.600[a]	1010.047[b]	988.260[c]	915.707[d]
Ash (mg/dL)	0.487[a]	0.587[b]	0.643[c]	0.683[c]
Water (mg/dL)	72.690[a]	72.980[ab]	73.920[ab]	74.197[b]

Different superscript in the same row indicate the significant differences (P<0.05)

Table 4: The Quality of the First Layed Egg of Quail Supplemented with Various Dosages of Turmeric Powder

Parameters	Dose of turmeric powder(mg/quail/day)			
	0	13.5	27	54
Egg weight (g)	8.714[a]	9.105[a]	8.998[a]	9.297[a]
Eggshell weight (g)	1.110[a]	1.113[a]	1.193[a]	1.200[a]
Eggshell thickness (g)	0.026[ab]	0.031[a]	0.024[b]	0.024[b]
Yolk diameter (cm)	2.173[a]	2.300[b]	2.319[b]	2.348[b]
Height of yolk (cm)	0.829[a]	0.875[a]	0.925[b]	1.033[c]
Height of albumin (cm)	0.443[a]	0.45[ab]	0.500[b]	0.500[b]
Weight of yolk (g)	2.427[a]	2.703[b]	2.680[b]	2.867[b]
Weight of albumin (g)	4.289[a]	4.698[a]	4.433[a]	4.567[a]
Yolk index	0.381[a]	0.380[a]	0.399[ab]	0.440[b]
Haugh index	91.394[a]	91.515[a]	94.143[b]	93.910[ab]
Eggshell index	6.104[a]	5.890[a]	6.350[a]	6.373[a]

Different superscript in the same row indicates the significant differences (P<0.05)

eggs were also increased by turmeric powder supplementation. During their stay in the reproductive tract, water content of the egg will increase two times to the levels of 3.5 to 7 grams of water per gram protein (Yuwanta, 2004; Etches, 1996).

The results of the experiment showed that turmeric powder supplementation increased yolk diameter, yolk height, albumin height, yolk weight, yolk index, and Haugh index without affecting egg weight, albumen weight, eggshell weight, eggshell thickness, and eggshell index (Table 4).

Turmeric powder supplementation at dosages of 27 and 54 mg/quail/day increased diameter and height of yolks and albumen. The increased diameter and height of yolk indicated an increase in vitellogenin synthesis by hepatocytes and deposited into the ovarian follicles. Increase in albumen showed that active substances in the

turmeric powder stimulated the growth of the epithelial cells and tubular gland cells in the magnum to synthesize and secrete albumen. Yolk index is a ratio between the height and the diameter of yolk. Normal yolk index is 0.33-0.5 with average of 0.4. Yolk index value was found to reach 0.59 in quail supplemented with turmeric powder. The highest average of yolk index, 0.44, was found in the quail supplemented with turmeric powder at the dosage of 54 mg/quail/day. Egg quality can also be measured by Haugh index. Supplementation of turmeric powder increased the haugh index. The highest haugh index found in the quail supplemented with turmeric powder reached 94.143, with a very good quality score. Haugh index of broken egg is less than 50.

CONCLUSION

Turmeric powder supplementation upto the levels of 54 mg/quail/day (with 7.97% of curcumin content) in quail improved lipid metabolism and its distribution to various organs, through the enterohepatic recirculation, abdominal fat deposition, and the ovarian follicle. Turmeric powder supplementation in quails improved protein and calcium metabolisms that finally improved egg quality. The delay in first laying time in quails fed turmeric powder was probably due to the increased number of ovarian follicles hierarchy.

ACKNOWLEDGMENTS

The authors thank to the Directorate General of Higher Education, Ministry of National Education of Republic Indonesia for providing BPPS scholarship, staff of Balitro-Bogor for helping in analyzing the levels of curcumin, staff of Wahana Laboratory, Semarang for helping in analyzing the blood and egg cholesterol concentrations. The authors also thank to students and the staff of Biology Department, Faculty of Science and Informatic, Diponegoro University, for assistance during the research.

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