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Physiological Condition of First Female and Male Offspring of Japanese Quail (*Coturnix japonica*) whose Parents were Supplemented by Turmeric Powder

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ABSTRACT

The study was carried out to determine the physiological condition of the first female and male offspring of Japanese quail (*Coturnix japonica*) whose parents were supplemented by turmeric powder. This study consisted of two stages. In the first stage, 45 female quails aged 1 week were divided into 3 groups; P0: control; P1: supplemented by 54 mg turmeric powder/quail/day, P2: supplemented by 108 mg turmeric powder/quail/day. Each group consisted of 15 quails. Fertile eggs were collected from each treatment and incubated until hatched. Forty five females and 45 males offspring quails were collected from each treatment. The second stage consisted of 3 groups; K0: offspring of quail whose parents were not supplemented by turmeric powder (P0); K1: offspring of quail whose parents were supplemented by turmeric powder 54 mg/quail/day (P1); K2: offspring of quail whose parents were supplemented by turmeric powder 108 mg/quail/day (P2). This study implemented completely randomized design experimental method. It is proven that turmeric powder supplementation increased the levels of vitellogenin, HDL, vitamin B12, vitamin A, white egg protein, linoleic acid, arachidonic acid in eggs. In contrast, the cholesterol levels, LDL and total fat of eggs decreased. However, no significant changes of the oleic acid level were observed. On the second stage for both K1 and K2 in the case of the first female offspring of Japanese quail, the weight of carcass, SGPT, cholesterol serum, triglycerides serum and liver cholesterol increased, but LDL and SGOT serum decreased. Beside the weight of carcass, there were no significant changes for other parameters of the first male offspring of Japanese quail.

Key words: Japanese quail, Quality of egg, Physiological condition, Turmeric powder

INTRODUCTION

Growth and development of quail offspring after hatching depends on the development of embryo during incubation. Normal embryonic growth and development depend on a complete supply of all required nutrients within the egg (Wilson, 1997). The quality of chemical substances in the yolk can be improved by giving turmeric powder supplement in the feed of the quail. This idea is rooted from the fact that turmeric powder contains curcumin of 7.97 % (Saraswati et al., 2013), antioxidant, anti-inflammatory, antibacterial and antivirus substances (Vashan et al., 2012; Kilany et al., 2014; Khosravifar et al., 2014; Alagawany et al., 2015) that have a role in improving liver function (Saraswati et al., 2013 and Nabavi et al., 2014). Liver is a place for vitellogenin biosintesis as a material to form yolk (Saraswati et al., 2013 and Moussavi et al., 2009). The triggering factor of vitellogenin synthesis is estrogen hormone that is synthesized under the axis hipotalamus-hipofisis-gonad regulation (Levi et al., 2009 and Hachfi et al., 2012). Estrogen receptor is located in cytosol or nucleus of targeted cells (Wollf et al., 2011; Khoshnoud et al., 2011 and Kocanova et al., 2010). Turmeric powder contains 6.79% of phytoestrogen (Saraswati et al., 2013), which has an activity to bind to the estrogen receptor (Turner et al., 2007 and Harris et al., 2005). Phytoestrogen with estrogen receptor binding causes an increase in vitellogenin synthesis (Levi et al., 2009).

Supplementation of turmeric powder increases levels of DNA in liver (Saraswati et al., 2013) with regard to the role of curcumin to induce several transcription factors, cytokinase, growth factors, and other enzymes. Turmeric powder supplementation causes estriol hormone fluctuation resulting in shortening one ovulation cycle for 2 hours 35 min (Saraswati et al., 2014).

Turmeric powder supplementation by 54 mg/ quail/ day could improve the physiological condition of quail,

increase vitellogenin level, and also increased the quality of yolk (Saraswati et al., 2013). Turmeric powder supplementation up to 108 mg/quail/day decreased the triglyceride level in the blood (Putra et al., 2015). Vitellogenin in the form of VLDL is transported from the liver through the blood stream system and brought to the ovary (Ito et al., 2003 and Vezina et al., 2003).

Egg yolk is the main source of protein, minerals, vitamins and lipids for the development of the embryo (Duce et al., 2011). Supplementation of turmeric powder accelerates the incubation period. Turmeric powder supplementation up to 108 mg/quail/day shortened the incubation period of quail embryo (Saraswati et al., 2015), because turmeric powder supplementation improved the physical and chemical quality of the first eggs of Japanese quail. Based on the above information, we studied the physiological condition of the first offspring Japanese quail females and males whose parents were given turmeric powder supplements.

MATERIAL AND METHODS

Material

One hundred *Coturnix japonica* at age of one day was obtained from Colomadu, Solo, Central Java, Indonesia. Turmeric powder was made from 8 kg turmeric rhizome at age of 9 months. Cages and equipments were fumigated with disinfectants before used. The DOQ was acclimated for 1 week. Each cage consisted of three quails.

Acclimation on battery cage

Acclimation was followed in a battery cages for one week. During the experiment feed and drinking water were provided *ad libitum*. Vita chick (PT. Medion, Indonesia) at dosage of 5 g/12 L water were given to the quail on the third day through drinking water. Anti-stress vitamins were given to increase endurance and prevent stress at the time before and after vaccination, after cutting the beak, transfer to other cage, bad weather, and a falling feather. Vaccination with Newcastle disease vaccine was given at the age of 3 days old and also at the age of 36 days old. These vaccines were delivered via eye drops.

Methods

This experiment consisted of two stages. In the first stage, a total of 45 female quails aged 1 week were divided into three experimental groups, the control group that received basal diet without turmeric powder (P0), second group treated by turmeric powder 54 mg/quail/day (P1), third group treated by turmeric powder 108 mg/ quail/ day (P2). Each group consisted of 15 quails. The treatment was given every day, starting at age of 15 days for 1 month. Each cage was given 1 male quail age three months so that the produced eggs were fertile eggs. The observed parameters were the content of vitellogenin, cholesterol, HDL, LDL, vitamin B12, vitamin A, protein of white egg, fat, oleic acid, linoleic acid and arachidonic acid of eggs that were produced in third month.

In the second stage, the physiological conditions of post-hatching quail offspring were observed. The fertile eggs were collected from eggs that were laid by quails at aged of 3 months from the controlled treatment and the one that was produced by quails treated with turmeric powder. The eggs were incubated in an incubator at temperature 37-38^{o}C with humidity 60% until hatched. Forty five female and 45 male offspring of quail that hatched from each treatment were collected. The experiment was divided into 3 groups; K0: offspring of quail whose parents were not supplemented by turmeric powder (P0); K1: offspring of quail whose parents were supplemented by turmeric powder 54 mg/quail/day (P1); K2: offspring of quail whose parents were supplemented by turmeric powder 108 mg/quail/day (P2). So, there were 135 female offsprings and 135 male offsprings of Japanese quail. They were maintained by giving the standard feed intake (crude protein 18.8%, fat content 3.5%, ash 10%, total carbohydrate 50.78% and crude fiber 6%) and drinking water *ad libitum.* Physiological condition of the offspring quails were observed by measuring the carcass weight and analyzing the chemical components of the blood taken at the end of the treatment. Blood was collected via vena jugularis and the serum was taken. Chemical analysis of blood consisted of SGPT and SGOT levels by Reitman and Frankle method (Bigoniya et al., 2009), glucose and cholesterol with CHO-PAP method (Elwakkad et al., 2012), triglycerides with GPO-PAP method (Bekal et al., 2011), serum HDL and LDL, and liver cholesterol by the Liebermann Burchard method (Puwastien et al., 2011).

The obtained data were analyzed using analysis of variance (ANOVA), Analyses were done by software SAS 9.1 for windows. Variant means were separated using Duncan's Multiple range Post hoc Test. P values <0.05 were considered significant.

RESULTS

The result of the first stage included the chemical quality of eggs produced in the third month from quails in control group and quails in supplemented by turmeric powder

group at dose of 54 mg/quail/day and 108 mg/quail/day presented in table 1. Results of the analysis of turmeric powder supplementation showed significant results in level of vitellogenin, cholesterol, HDL, LDL, vitamin B12, vitamin A, white protein, total fat, linoleic acid, arachidonic acid of eggs ($P<0.05$). There was no significance at levels of oleic fatty acid ($P> 0.05$). The levels of vitellogenin, HDL, vitamin B12, vitamin A, protein of white egg, linoleic acid and arachidonic acid increased, but the levels of cholesterol and fat decreased.

Physiological condition of the first offspring of female quails whose parents were supplemented by turmeric powder for a month before being sexually mature are described in table 2. The results showed that turmeric powder supplementation had a significant effect on the physiological condition of the first offspring of female quails including the levels of SGPT, SGOT, triglycerides serum, serum LDL, liver cholesterol and carcass weight ($P <0.05$), but not significant on levels of blood glucose and serum HDL ($P> 0.05$). Levels of SGPT, serum cholesterol and triglycerides, liver cholesterol, and carcass weight increased, however, levels of serum SGOT and LDL decreased.

Physiological condition of the first male offspring of quails whose parents were supplemented by turmeric powder for a month before being sexually mature presented in table 3. The analysis results of the effect of turmeric powder supplementation to the physiological condition of the first male offspring of quails indicated that they were not significant in level of SGPT, SGOT, glucose, cholesterol, triglycerides, LDL, HDL serum, liver cholesterol, and carcass weight ($P > 0.05$).

Table 1. Chemical quality of eggs produced by Japanese quail at age of three month after turmeric powder supplementation

Parameter	P0 (Control)	P1 54 mg/quail/day	P2 108 mg/quail/day
Vitellogenin (mg/100g)	0.77±0.31^{b}	0.95±0.11^{b}	1.13±0.57^{a}
Cholesterol (mg/100g)	747.63±23.82^{a}	689.51±19.45^{b}	653.27±12.69^{c}
HDL (mg/100g)	108.33±4.07^{b}	112.91±4.98^{b}	121.06±5.79^{a}
LDL (mg/100g)	139.56±6.74^{a}	128.71±2.99^{b}	121.04±4.86^{c}
Vitamin B12(mg/100g)	1.29±0.05^{c}	1.48±0.11^{b}	1.66±0.07^{a}
Vitamin A (SI)	543.72±12.44^{c}	555.39±17.13^{b}	575.47±11.23^{a}
Protein of white egg (%)	16.12±0.87^{b}	17.56±0.67^{a}	17.55±0.62^{a}
Fat(%)	31.15±1.64^{a}	30.03±0.21^{b}	28.92±0.77^{b}
Oleic acid (%)	1.99±0.12	2.06±0.06	2.09±0.08
Linoleic acid (%)	0.49±0.06^{b}	0.53±0.04^{b}	0.64±0.03^{a}
Arachidonic acid (%)	0.034±0.01^{b}	0.04±0.01^{b}	0.06±0.01^{a}

Different small letters in superscript at the same row indicate a significant result ($P < 0.05$); P0: Control group; P1: Supplemented by 54 mg turmeric powder/quail/day; P2: Supplemented by 108 mg turmeric powder/day

Table 2. Biochemical parameters and carcass weight of the first female offspring of Japanese quail aged two months whose parents were supplemented by turmeric powder

Parameter	K0	K1	K2
Carcass weight (g)	65.56±0.82^{b}	71.40±3.29^{a}	69.03±0.88^{a}
SGPT (U/L)	33.47±0.95^{b}	33.44±0.19^{b}	34.07±0.05^{a}
SGOT (U/L)	31.92±0.36^{b}	31.32±0.33^{ab}	31.25±0.05^{a}
Blood glucose (mg/dl)	109.59±0.24^{a}	107.99±1.12^{b}	109.8±0.5^{a}
Cholesterol serum (mg/dl)	99.82±0.5^{b}	100.09±0.01^{b}	101.08±0.62^{a}
Triglycerides serum(mg/dl)	53.25±0.16^{b}	52.18±0.11^{b}	54.08±0.96^{a}
LDL serum (mg/dl)	42.73±0.16^{a}	42.4±0.9^{b}	42.15±0.01^{c}
HDL serum (mg/dl)	44.81±1.56^{a}	44.59±0.61^{a}	44.08±0.52^{a}
Liver Cholesterol (mg/100g)	199.1±0.92^{b}	200.19±0.19^{b}	202.99±1.69^{a}

Different small letters in superscript at the same row indicate a significant result ($P < 0.05$); K0: offspring of quail whose parents were not supplemented by turmeric powder (P0); K1: offspring of quail whose parents were supplemented by turmeric powder 54 mg/quail/day (P1); K2: offspring of quail whose parents were supplemented by turmeric powder 108 mg/quail/day (P2).

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Table 3. Biochemical parameters and carcass weight of the first male offspring of Japanese quail aged two months whose parents were supplemented by turmeric powder

Parameter	K0	K1	K2
SGPT (U/L)	34.05±0.2[a]	34.13±0.02[a]	34.46±0.64[a]
SGOT (U/L)	31.7±0.75[a]	31.78±0.8[a]	32.2±0.15[a]
Blood glucose (mg/dl)	109.33±0.73[a]	110.83±0.82[a]	108.24±4.89[a]
Cholesterol serum (mg/dl)	98.83±1.19[a]	101.89±0.9[a]	101.52±3.15[a]
Triglycerids serum(mg/dl)	54.37±0.45[a]	54.96±0.4[a]	54.89±1.25[a]
LDL serum (mg/dl)	42.26±0.19[a]	43.07±0.2[a]	43.04±0.76[a]
HDL serum (mg/dl)	45.97±0.14[a]	44.79±0.7[a]	44.81±1.28[a]
Liver cholesterol (mg/100g)	198.03±6.72[a]	199.47±1.47[a]	203.67±7.09[a]

Note: Different small letters in superscript at the same row showed a significant result ($P < 0.05$); K0: offspring of quail whose parents were not supplemented by turmeric powder (P0); K1: offspring of quail whose parents were supplemented by turmeric powder 54 mg/quail/day (P1); K2: offspring of quail whose parents were supplemented by turmeric powder 108 mg/quail/day (P2).

DISCUSSION

The increase in dose of turmeric powder supplementation up to 108 mg/quail/day increased the levels of vitellogenin in yolk. The results of previous studies showed that turmeric powder increased levels of vitellogenin in plasma (Saraswati et al., 2013). The more vitellogenin were synthesized, there were more follicles developed (Saraswati et al., 2013). As more follicle hierarchies were developed, vitellogenin were distributed to many follicles, which lead to the reduction in cholesterol levels as a constituent of vitellogenin. Finally, egg cholesterol levels decreased. According to Qinna et al. (2012), curcumin induces changes in the expression of genes involved in cholesterol homeostasis. The homeostasis of cholesterol in body mainly depends on its synthesis, absorption from intestine and secretion of the bile, of which the metabolic process is under precise regulation (Li et al., 2015). Curcumin acts on the stimulation of the enzyme activity of hepatic cholesterol-7α-hydroxylase, which catalyzes the conversion of cholesterol into bile salts. Due to stimulation of this enzyme by curcumin, the changes in hepatic cholesterol into bile salts were increased, resulting in decreased levels of cholesterol. Since curcumin has the ability to activate genes in liver cells to increase production of LDL receptors, turmeric powder supplementation lowered LDL levels quail eggs (Peschel et al., 2007). With the increase in the available LDL receptors, liver cells could eliminate a large amount of LDL cholesterol in the blood so that LDL in eggs also decreases. Reduction of LDL in the egg was followed by an increase of HDL levels in eggs.

The results indicated that turmeric powder can increase the level and absorption of vitamin B12 and vitamin A in eggs. Vitamin B 12 is soluble in water, while vitamin A is fat soluble (Park et al., 2015). Turmeric helps in the digestion of food and absorption of fats and fat-soluble vitamins. Turmeric is also known to assist and improve the intestinal flora. Supplementation by 2 g/kg of curcumin increases mucous colonies 1.8 mol/g (Irving et al., 2011). Curcumin could alter the motility of *Salmonella*, a bacterium pathogen in the intestine (Marathe et al., 2016), so that the absorption in the intestine can be advanced.

The protein in eggs was found in the white part of the egg. The white part of the egg is secreted when the egg passes through the magnum part of the reproductive tract. The more hierarchies' follicles developed; there would be more follicles that ovulated. It will lead the cells in the magnum to synthesize and secrete the white egg, so that proteins in egg will be increased. From the analysis of essential fatty acids in eggs, it was indicated that turmeric powder could improve metabolic processes of essential fatty acids which was shown with the increase of the content of essential fatty acids include linoleic acid, arachidonic acid, but had not led to an increase in oleic acid. Results of the first stage of the study showed an increase in chemical quality of quail eggs which were supplemented by turmeric powder.

Supplementation of turmeric powder to quail for a month before becoming sexually mature affects the physiological condition of the first female offspring quails. Improvement of physiological conditions of the first offspring quails female were indicated by an increase in carcass weight. This is in line with the research conducted by (Yudha et al., 2013), turmeric powder supplementation increases quail's muscle diameter. Carcass weight is a product of metabolism produced by the organism.

Physiological conditions of the first offspring of quails were determined by the development of embryo during the incubation period. Embryo of quail whose parents were given turmeric powder supplements before becoming sexually mature will be born 2 days faster than usual (Saraswati and Tana, 2016). The development during embryonic period was influenced by the nutrients stored in the yolk.

Along with the increased activity of liver in the vitellogenin biosynthesis, there was also an increase in metabolic processes, as shown by an increase of cholesterol in liver and also cholesterol and triglycerides in serum. Vitellogenin biosynthesis occurs in the liver, so that the liver cholesterol levels increased. Vitellogenin subsequently transported through the bloodstream to the ovaries and will accumulate as the yolk, so that the levels of cholesterol and triglycerides in the blood experienced a slight increase, but still in the normal range. Increased activity of liver cells can cause damage in some cells. This damage was indicated by the increased levels of SGPT level, but the SGPT was still at normal level (<35 U/L). Increased SGPT is an indicator of liver damage (Parmar et al., 2016). There was no significant difference in SGOT and it was at normal levels (< 45) which suggests that the internal organs were also in good condition.

Increased physiological conditions of the first female offspring of quail were also shown by the decrease of LDL levels in serum. Turmeric powder supplementation was able to induce the formation of LDL receptors, resulting in decreased levels of LDL serum in the first female offspring of quail. Curcumin induces genes activation in the liver cells to increase production of mRNA, thereby increases the production of LDL receptors in the liver. With the increased amount of available LDL-receptors, liver cells can eliminate a large amount of LDL cholesterol from the body. Curcumin can enhance the liver cells to synthesize LDL receptor mRNA seven times more compared to cells that did not receive curcumin (Peschel et al., 2007). The decrease in LDL levels has not been followed by an increase in serum HDL levels. There was significance for the level of blood glucose between K0 and K1 and also between K1 and K2, but between K0 and K2 there was no significant differences. However, blood glucose level for all K0, K1, and K2 were still in normal condition. This suggests that the metabolic processes that occur in the body are running well.

Physiological conditions of the first male offspring of quails did not show any significant in all parameters and at normal conditions. The insignificance was due to the physiological activity of male quails was simpler than the physiological activity of female quail. The first female offspring of quails whose parents were given turmeric powder supplements started to produce eggs at the age of 42 days, so that the metabolism activity became more complex and happened at early age.

CONCLUSION

From the results of this study, it can be concluded that supplementation of turmeric powder was capable to improve the chemical quality of eggs. Eggs are a good source of nutrients for the development of the embryo, so that better physiological conditions of male and female offspring of quail can be obtained after consuming the turmeric powder.

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Competing interests

The authors of present study have no competing interest to declare.

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