Supplementation of Mangosteen Pericarp Meal and Vitamin E on Egg Quality and Blood Profile of Laying Hens

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ABSTRACT

This research aimed to study the supplementation effects of mangosteen pericarp meal (MPM) and vitamin E (VE) in the diets on the egg quality and blood profile of laying hens. This research used 160 laying hens of Lohman strains 24 weeks of age. The observation was conducted for 11 weeks. A completely randomized design with four treatments and four replications (10 birds each) was used in this experiment. The treatments consisted of R0 (control diet), R1 (R0 + 1 g MPM/kg ration), R2 (R0 + 2 g MPM/kg ration) and R3 (R0 + 200 mg VE/kg ration). Variables measured were egg quality, yolk cholesterol, and blood profiles. The data were analyzed by using analysis of variance (ANOVA) and any significant difference between the treatment means were further tested by Duncan’s Multiple Range Test. The results showed that supplementation of 1 g MPM/kg ration in the diet significantly (P<0.05) decreased blood triglycerides compared with the control, laying hens fed with diet supplemented with 2 g MPM/kg ration, and laying hens with diet supplemented with 200 mg VE/kg ration. Supplementation of MPM and VE did not affect (P>0.05) egg quality (except shell thickness), blood cholesterol, and HDL, respectively. In conclusion, supplementation of 1 g MPM/kg in the diet of laying hens could decrease blood triglycerides.

Key words: blood profile, laying hens, mangosteen pericarp meal, egg quality, vitamin E

ABSTRAK

Penelitian ini bertujuan untuk mengkaji pengaruh suplementasi tepung kulit manggis (TKM) dan vitamin E (VE) di dalam ransum pada kualitas telur dan profil darah ayam petelur. Penelitian ini menggunakan 160 ekor ayam petelur strain Lohman umur 24 minggu yang dipelihara selama 11 minggu. Rancangan yang digunakan adalah rancangan acak lengkap dengan 4 perlakuan dan 4 ulangan (10 ekor setiap ulangan). Perlakuan terdiri atas R0 (pakan kontrol), R1 (R0 + 1 g TKM/kg as fed), R2 (R0 + 2 g TKM/ kg as fed), dan R3 (R0 + 200 mg VE/ kg as fed). Peubah yang diukur adalah kualitas fisik telur, kolesterol telur, dan profil darah. Data yang diperoleh dianalisis secara statistik menggunakan analysis of variance (ANOVA) dan jika terdapat perbedaan nyata antar perlakuan maka dilakukan uji lanjut Duncan’s Multiple Range Test. Hasil penelitian menunjukkan bahwa suplementasi 1 g TKM/kg as fed di dalam ransum menurunkan (P<0,05) trigliserida darah jika dibandingkan dengan kelompok kontrol, ayam petelur yang diberi makan ransum yang disuplementasi 2 g TKM/kg as fed, dan 200 mg VE/kg as fed. Perlakuan suplementasi TKM dan VE tidak mempengaruhi (P>0,05) kualitas telur (kecuali tebal kerabang), kolesterol darah, dan HDL. Kesimpulannya, suplementasi 1 g TKM/kg as fed dalam ransum ayam petelur dapat menurunkan kadar trigliserida darah.

Kata kunci: profil darah, ayam petelur, tepung kulit manggis, kualitas telur, vitamin E

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INTRODUCTION

Chicken's egg is one of primary poultry products that can be used as animal protein source with rich nutrient content and easily found by consumers. Egg quality is defined by external and internal properties. External properties include shell cleanliness, color, shape and soundness of shell. Meanwhile, internal properties include, relative viscosity of albumen, yolk shape, yolk color and nutrient content (Hussain et al., 2013). Egg quality recently gains attention not only in farmer level but also in industry and consumer levels. Various aspects such as genetic, nutrient, breeding system, environment and post-harvest handling are interesting studies in order to produce and improve the quality of egg.

Ambient temperature is one of important factors that should be considered in breeding chicken in order to produce good quality of eggs. High temperature in Indonesia may cause flocks to experience heat stress leading to the formation of free radical, productivity and metabolism disorder thereby affecting the quality and quantity of eggs (Gu et al., 2008; Mujahid et al., 2007; Sugito, 2009). Efforts have been done to overcome those problems such as using antioxidant. Recently, mineral and vitamin are commonly used as antioxidants.

Vitamin E (VE) is the major antioxidant component in biological system which plays an important role in metabolism process, protecting cellular structure and maintaining membrane stability from free radical. A number of researches reported that VE is able to fix and increase performance (Ajakaiye et al., 2011; Ciftci et al., 2005), egg production (Bolukbasi et al., 2007; Ciftci et al., 2005; Irandoust et al., 2012), quality of eggs (Ciftci et al., 2005; Jiang et al., 2013), immune system (Asli et al., 2007; Da Silva et al., 2009; Iqbal et al., 2015), and decrease malondialdehyde (Brenes et al., 2008; Goni et al., 2007; Jiang et al., 2013; Voljc et al., 2011) during heat stress.

Mangosteen pericarp is a part of mangosteen fruit which has long been known as a medicine for diarrhea, skin infections as well as for coloring foodstuffs and textiles. The main chemical compound of mangosteen pericarp is xanthone and its derivative (Jung et al., 2008; Gutierrez-Zorozco & Failla, 2013; Pedraza-Chaveri et al., 2008). Accordingly, a study on the supplementation of the laying hens diets with mangosteen pericarp meal (MPM) and VE was carried out to determine their effects on egg physical quality, egg cholesterol, blood cholesterol, triglyceride and high-density lipoprotein.

MATERIALS AND METHODS

Design, Animal, and Diet

This research used 160 laying hens (Lohman strain, Japacom feed, Indonesia), aged 24-weeks old. This research used four feeding treatments: R0 (control diet), R1 (R0 + 1 g MPM/kg ration as fed), R2 (R0 + 2 g MPM/kg ration as fed), R3 (R0 + 200 mg VE/kg ration as fed) with four replications. Each replication used 10 chickens (2 hens/cage, the dimensions for each cage were 35 x 36 x 42 cm). Drinking water was provided ad-libitum and feeding was given twice a day i.e in the morning (07.00 am) and afternoon (05.00 pm). This research was carried out for 11 weeks. Cage was equipped with lamp for 16L:8D.

Mangosteen pericarp was obtained from smallholders’ estate area in Leuwiliang, Bogor, West Java. MPM was processed by using drying oven during 5-6 h (LTE scientific Swallow, UK) at a temperature of 50 °C, then ground using a disk mill machine (Jiayu Electrical Machinery, Taiwan). VE used in this research was vitamin E, 40 mg/g α-tocopherol acetate (Interchemie, Netherlands).

Feed ingredients consisted of maize, soybean meal, fish meal, coconut oil, CaCO3, salt, DL-Methionine, and premix. Feed requirement of laying hens was defined by Leeson & Summers (2005) method with the metabolizable energy content of 2900 kcal/kg and 17% crude protein. The Ingredient and nutrient content used in this research are as shown in Table 1. All research procedures had been approved by the animal ethic committee, Bogor Agricultural University No.12-2014 IPB.

Table 1. Ingredient and nutrient contents of basal diets

| Ingredients | Contents |
|-------------|----------|
| Maize (%)   | 55.00    |
| Soybean meal (%) | 24.00   |
| Fish meal (%) | 8.50    |
| Coconut oil (%) | 3.00    |
| CaCO3 (%)   | 8.50     |
| Salt (%)    | 0.20     |
| DL-Methionine (%) | 0.30   |
| Premix (%)  | 0.50     |

Nutrient content a:

- Metabolizable energy (kcal/kg): 2900.75
- Crude protein (%): 17.19
- Crude fiber (%): 2.18
- Crude fat (%): 5.32
- Ca (%): 3.83
- Available P (%): 0.49
- Methionine (%): 0.73
- Lysine (%): 1.33
- Cystine (%): 0.34
- Tryptophan (%): 0.27
- Threonine (%): 0.95
- Arginine (%): 1.42
- Na (%): 0.15
- Zinc (mg/kg): 38.55

Note: a Premix provided (in mg/kg premix)= vit A 500,000 IU; vit D 100,000 IU; vit E 150 mg; vit K 50 mg; vit B1 50 mg; vit B2 250 mg; vit B12 250 mcg; niacinamide 375 mg; Ca-d-panthotenate 125 mg; folic acid 25 mg; choline chloride 5,000 mg; Glycine 3,750 mg; DL-methionine 5,000 mg; Mg sulphate 1,700 mg; Fe sulphate 1,250 mg; Mn sulphate 2,500 mg; Cu sulphate 25 mg; Zn sulphate 500 mg; K iodine 5 mg. b Calculated value.

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TABLE 2. Physical quality of eggs produced by laying hens supplemented with mangosteen pericarp meal (MPM) and vitamin E (VE)

| Variables Observed | R0                      | R1                      | R2                      | R3                      |
|--------------------|-------------------------|-------------------------|-------------------------|-------------------------|
| Egg weight (g)     | 53.91±1.68              | 53.79±0.77              | 52.33±1.27              | 53.69±1.11              |
| Egg shell (%)      | 12.19±0.58              | 12.24±0.57              | 12.27±0.29              | 11.91±0.23              |
| Yolk (%)           | 23.19±1.01              | 23.88±0.90              | 23.69±0.43              | 23.08±1.06              |
| Albumin (%)        | 64.63±1.19              | 63.88±1.24              | 64.05±0.23              | 65.01±1.08              |
| Shell thickness (mm) | 0.33±0.01             | 0.33±0.00               | 0.32±0.01              | 0.31±0.01              |
| Yolk color         | 8.05±0.37               | 8.13±0.36               | 8.27±0.20               | 8.55±0.45               |
| Haugh unit         | 98.01±1.41              | 98.93±2.44              | 98.75±1.47              | 98.27±2.79              |
| Shell color        | 8.52±0.04               | 8.19±0.31               | 8.23±0.47               | 8.16±0.72               |

Note: Means in the same row with different superscripts differ significantly (P<0.05). R0= control feed, R1= R0 + 1 g MPM/kg ration as fed, R2= R0 + 2 g MPM/kg ration as fed, R3= R0 + 200 mg VE/kg ration as fed.
Yolk color is influenced by the type of pigment contained in the diet. The application of MPM and VE in the diet (Table 2) did not increase yolk color score, although MPM contained pigment which derived from secondary metabolites such as: anthocyanins (Palapol et al., 2009).

Shell color in this study was not affected by the supplementation of MPM and VE. The main factor that affects shell color is biliverdin pigment (Zhao et al., 2006; Wang et al., 2009), phorpyrin (Wang et al., 2009), genetic (Zhang et al., 2005), stress level, age and disease (Aygun, 2014). Brown shell color is influenced by phorpyrin pigment which composed of protophorpyrin, coproporphyrin, pentacarboxylic porphyrin, uroporphyrin and some types of unidentified phorpyrin (Wang et al., 2007). Protoporphyrin pigment is produced during the heme globin (Hb) process (Kennedy & Vevers, 1973). This pigment is transported from the liver to the uterus through the blood. Based on Hb values (unpublished data), there was a correlation between Hb and shell color. The increasing of Hb increased shell color and vice versa.

Haugh units (HU) of egg found in this study was not influenced by the supplementation of MPM and VE. This finding is in accordance with the finding of Irandoust et al. (2012) that the addition of VE 348 IU/kg does not affect the HU value. HU values in this study ranged between 98.01-98.93 and these values were classified into AA quality i.e. > 72 (Unites State Department of Agriculture, 2000).

**Yolk Cholesterol**

Yolk cholesterol as resulted of the supplementation of MPM and VE in the diet is shown in Table 3. The result showed that the supplementation of 1 g MPM/kg ration as fed significantly increased egg cholesterol (P<0.05). The average value of yolk cholesterol was R0 (4.91 mg/g), R1 (6.15 mg/g), R2 (5.41 mg/g) and R3 (5.24 mg/g). Supplementation of 1 g MPM/kg ration as fed increased the egg cholesterol as compared to control, supplementation of 2 g MPM/kg ration as fed and 200 mg VE/kg ration as fed. This is due to the ability of MPM as an antioxidant that can protect lipid (TG, phospholipid and cholesterol). It also can protect protein which role as a precursor for yolk formation that it used for the development of embryo by inhibiting free radical resulted from high temperature that can damage tissue.

Yolk precursor (lipid and lipoprotein) is synthesized in the liver supported by estrogen hormone and then circulated to ovaries by blood for follicle maturation and formation. Cholesterol is classified into lipid which is required by a hen as a source of feed material for small cell (blasto-derm) and then used by embryo during hatching and to support growth after hatching (McGraw, 2006).

Cholesterol content of yolk significantly affected the lipid composition of embryonic tissue. Avian embryonic tissue contains unsaturated fatty acids in the fat fraction, thus it requires an effective antioxidant protection. Antioxidant defense tissue of newly hatched birds are composed of fat-soluble antioxidants (vitamin E, carotenoids), water soluble (ascorbic acid and glutathione), and antioxidant enzyme (SOD, GSH-Px and catalase) (Surai, 2003).

**Blood Profiles**

The effect of ration supplemented with MPM and VE on cholesterol, TG, and HDL is presented in Table 3. The result showed that MPM supplementation in the diet significantly reduced TG level (P<0.05). However, MPM and VE supplementation did not affect (P>0.05) cholesterol and HDL concentrations in the blood.

TG ranged between 522.63-753.9 mg/dl. MPM supplementation in the treatment of R1 and R2 showed lower TG levels compared with R0 and R3 treatment. Low level of TG was due to the influence of antioxidant which contained in MPM diet that inhibited free radical that could interfere TG hydrolysis. Antioxidant contained in MPM is not only α-mangosteen (40 ppm), but also there are saponin (8.24 g/100g) and tannin (32.49 g/100g). Saponin (0.08 g) and tannin (0.32 g) can reduce TG. In this case tannin can increase the activity of lipoprotein lipase (LPL) enzyme (Kothari et al., 2011). The increasing activity of LPL enzyme will break down TG into glycerol and fatty acids and will be released into the blood vessels to be transferred to the destined cells (Piliang & Djosoedibagio, 2006). The tolerance limit of tannins in chicken feed is 2.6 g/kg (Kumar et al., 2005) and saponins at 4.5 g/kg ration (Abbas, 2013).

In R3 treatment, supplementation of vitamin E in the diet was not able to lower TG level in the blood. R3 resulted higher TG level compared to R0 treatment. The increased TG was relatively followed by the increased VLDL and LDL. On the contrary, the increased of HDL was relatively followed by the decreased of VLDL and LDL, vice versa.

### Table 3. Yolk cholesterol, blood cholesterol, triglyceride, and blood high-density lipoproteins (HDL) in laying hens supplemented with mangosteen pericarp meal (MPM) and vitamin E (VE)

| Variables          | Treatments | R0       | R1       | R2       | R3       |
|--------------------|------------|----------|----------|----------|----------|
| Yolk cholesterol (mg/g) | R0        | 4.91±0.15<sup>a</sup> | 6.15±0.31<sup>b</sup> | 5.41±0.44<sup>a</sup> | 5.24±0.43<sup>b</sup> |
| Blood cholesterol (mg/dl) | R0        | 138.91±11.24 | 106.0±17.89 | 115.82±27.87 | 118.73±20.25 |
| Triglyceride (mg/dl) | R0        | 730.45±66.81<sup>a</sup> | 522.63±67.71<sup>b</sup> | 612.65±118.60<sup>b</sup> | 753.09±84.14<sup>a</sup> |
| HDL (mg/dl)        | R0        | 14.89±1.48  | 15.75±1.95 | 14.00±1.39  | 17.58±3.02  |

Note: Means in the same row with different superscripts differ significantly (P<0.05). R0= control feed, R1= R0 + 1 g MPM/kg ration as fed, R2= R0 + 2 g MPM/kg ration as fed, R3= R0 + 200 mg VE/kg ration as fed.
Table 3 showed that there was a decrease trend in blood cholesterol of hen supplemented with MPM and VE. It is due to MPM and VE act as an antioxidant which can protect lipids from free radicals. Therefore, cholesterol that has been synthesized in the liver during production phase, then carried by the blood in the form of lipoproteins and stored in follicle growing and forwarded to the ovary. MPM absorption in the body is associated with fat digestion in the small intestine (Guiterez-orozco & Failla, 2013) as well as VE (Surai, 2003).

MPM and VE supplementation in the ration did not affect on HDL (Table 3). In this case, MPM and VE can not increase the synthesis and secretion of HDL in the liver and intestine. The functions of HDL, i.e.: (1) can not increase the synthesis and secretion of HDL in the liver (reverse cholesterol transport) to be converted in the form of bile salts (Hardinia et al., 2007), (2) storage area for apolipoprotein C and E which are needed in the chylomicrons and VLDL catabolism. Apolipoprotein C is a cofactor of lipase lipoprotein and apolipoprotein E is a ligand for the LDL receptor (Adiputro et al., 2013).

CONCLUSION

Supplementation of 1 g MPM/kg as fed in laying hens diet could reduce TG concentration in the blood. The supplementation of MPM and VE did not affect the egg quality (except shell thickness), blood cholesterol, and HDL.

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