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Durian seed meal for commercial layers: performance, nutrient retention and egg quality

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ABSTRAK

Penelitian ini dilakukan untuk mengevaluasi pakan yang mengandung tepung biji durian (*Durio zibethinus* Murr) (DSM) terhadap penampilan, retensi nutrisi dan kualitas telur ayam petelur komersial. Sebanyak 120 lima puluh ekor ayam petelur berumur dua minggu didistribusikan menurut Rancangan Acak Lengkap dalam empat perlakuan dan lima ulangan dengan masing-masing enam ekor. Perlakuan terdiri dari berbagai kadar tepung biji durian (kontrol, DSM 3%, DSM 6%, dan DSM 9%). Pakan yang mengandung tepung biji durian tidak berpengaruh nyata (p> 0,05) terhadap konsumsi pakan ayam petelur umur 58 minggu. Kadar DSM hingga 6% dalam pakan ayam petelur tidak mengurangi produksi telur dan daya cerna nutrisi, tetapi mengurangi bobot telur. Tidak ada perbedaan (P> 0,05) yang diamati pada kadar kalsium telur, massa kalsium telur, dan skor warna kuning telur yang diberi pakan yang mengandung DSM. Studi ini menunjukkan bahwa DSM dapat campurkan hingga 6% dalam pakan ayam petelur tanpa efek buruk pada kinerja produksi, retensi nutrisi dan kualitas telur.

Kata kunci : kecernaan, produksi telur, berat telur, warna kuning telur

ABSTRACT

This study was conducted to evaluate diets containing durian (*Durio zibethinus* Murr) seed meal (DSM) on the performance, nutrient retention and egg qualities of commercial layers. A total of 120 fifty two -week-old laying hens were distributed according to a completely randomized design in four treatments and five replications with six birds each. The treatments consisted of different levels of durian seed meals (control, 3% DSM, 6% DSM, and 9% DSM). Feeding diets containing durian seed meal had no significant effect (p > 0.05) on the feed consumption of laying hens at 58 wk of age. Inclusion of up to 6% DSM in formulated layer diets did not reduce egg production and nutrient digestibility, but reduced egg weight. No differences (p>0.05) were observed in egg calcium content, egg calcium mass, and yolk color score fed diets containing DSM. This study suggests that DSM could be incorporated up to 6% in laying hen diets without adverse effect on production performance, nutrient retention and egg qualities.

Keywords: digestibility, egg production, egg weight, yolk color

INTRODUCTION

Durian (*Durio zibethinus* Murr) seed is a waste of durian fruit, and it becomes an environmental pollutant without proper handling and utilization. Durian is one of the most popular fruits in tropical countries. In Indonesia, the Central Bureau of Statistics of the Republic of Indonesia states that the average durian production had increased from 17,405 tons in 1999 to 741,831 tons in 2003 and to 883,969 tons by the end of 2011 (Cornelia *et al.,* 2015). Indonesian people consume durian fruit as fresh fruit and processed food, for instance, *wingko*, *lempok*, *dodol*, chips, and various drinks. In the processing of durian industries, waste is produced in the form of durian seeds. Assuming 10% of durian seed proportion of the total durian fruit, 1017 tons of durian seeds are produced annually. In this respect, durian seeds have a high potential to be used as a feed ingredient in laying hen diets.

Proximate data indicated that durian seed contains 67.43% carbohydrates, 6.43% protein, 1.48% fat, 6.15% crude fiber, 0.92% calcium, and 0.89% phosphorus (Suhaidi, 2004). In addition, durian seed contains polysaccharide gels and antioxidants have been reported to be beneficial in terms of disease resistance and health of the host (Amin *et al*., 2007; Haruenkit *et al.*, 2010). Durian seed meal has also been shown to contain antinutritional factors in the form of cyclopropenoid fatty acid (CFA) and oxalic acid (Ho and Bhat, 2015). However, excessive amounts of durian seed meal have a negative effect on feed consumption, digestibility, and nutrient retention that may adversely affect egg production and quality. Particular attention was given to CFA that this fatty acid may interfere with fat metabolism, alter the ratio of saturated to unsaturated fatty acids (Cao *et al.*, 1996), and affect the egg white color (Panigrahi, 1992). Oxalic acid is another antinutritional factor in durian seed meal that changes calcium to calcium oxalate that is not absorbed by laying hens. This situation may induce low calcium absorption, resulting in thin eggshells, brittle eggs, and soft-shelled eggs. Furthermore, oxalic acid can inhibit lipase activity, thereby reducing digestion and absorption of fat in the intestine (Elkin, 2017). Considering the potential negative effects of the antinutritional factors in durian seed meal, it is important to determine proper inclusion levels of durian seed meal in laying hens diets.

Previous research has demonstrated that durian seed meal can be included in quail diets at a level of up to 5% and that the consumption and productivity of quails decreased at levels exceeding 5% (Sardina, 2015) and Suhaidi (2004) documented that the diets fed to broiler chickens should not contain >10% of durian seed meal, because a higher inclusion level may adversely affect the production parameters. To the best of our knowledge, there is a scarcity of information regarding the utilization of durian seed meal as a feed ingredient in laying hen diets. Therefore, the objective of this study was to evaluate feeding durian seed meal to laying hens which offered the high performance, nutrient retention, and egg qualities.

MATERIALS AND METHODS

Durian Seed Meal Preparation

Durian seeds were collected from local fruit processing industries around Semarang, Central Java, Indonesia. The seeds were washed and boiled for 30 min at 100°C, followed by cooling, cutting into sizes of 1 to 2 cm, and sun drying for 3 days. Dried durian seeds were eventually ground into meal and then subjected to proximate analysis according to AOAC (1995). Oxalic acid content was determined using high-performance liquid chromatography method) and CFA used gas chromatography-mass spectrometry [GC-MS] method. Proximate analysis of durian seed meal and the contents of oxalic and cyclopropenoic acids are presented in Table 1.

Diets and Experimental Design

The study was laid out in a completely randomized design using a total of 120 fifty two-week-old laying hens (strain Lohmann Brown) with an average body weight of 1815 ± 174 g (mean ± standard deviation). The hens were randomly divided into four dietary regimens and five replications with six birds per pen. They were raised in cages, with two hens placed in a 40 × 45 cm^2 cage. The treatments consisted of different levels of durian seed meals (control, 3% DSM, 6% DSM, and 9% DSM). The study was conducted for a period of 6 wk, ranging from 52 to 58 wk of age. Composition and nutrient content is presented ini Table 2.

Data Collection and Analysis

Data on feed consumption, egg production, and egg weight were recorded daily. The parameters observed in this study were feed

Table 1. Chemical Composition of Durian Seed Meal before and after Boiling

Items	Fresh Durian seed meal	Boiled Durian seed meal
Moisture (%)[1]	9.94	10.2
Ash (%)[1]	3.78	3.65
Crude fat (%)[1]	2.76	2.84
Crude protein (%)[1]	7.66	7.79
Crude fiber (%)[1]	14.3	19.0
Calcium (%)[1]	0.03	0.04
Phosphorus (%)[1]	0.07	0.09
Metabolizable energy (kcal/kg)[2]	2.966	2.780
Oxalic acid (%)[3]	1.01	0.38
Cyclopropenoic acid (%)[3]	0.87	0.63

[1]*Analysis was conducted by the Laboratory of Nutrition and Feed Science, Faculty of Animal and Agricultural Sciences, Diponegoro University, Semarang*

[2]*Metabolizable energy was calculated based on a formula (Bolton 1967) as follows: 40.81 {0.87 [CP + 2.25 crude fat + nitrogen-free extract] + 2.5}*

[3]*Analysis was conducted by the Integrated Research and Testing Laboratory, Gadjah Mada University, Yogyakarta*

consumption, nutrient retention, and egg qualities. Feed consumption, egg production and egg weight were recorded daily. Daily CFA intake (DCI) and daily oxalic intake (DOI) were calculated feed consumption multiplied by the feed CFA or oxalic level. Nutrient retention was determined at the end of the trial and was measured by the amount of nutrient consumed minus the amount of nutrient excreted through excreta (Meluzzi *et al.*, 2001; Kong and Adeola, 2014). The feed conversion ratio (FCR) was calculated as feed consumption (g) divided by egg mass (g). Egg quality characteristics were measured as egg weight, eggshell weight, shell calcium level, eggshell calcium mass, calcium level in egg contents, egg protein content, egg protein mass, and egg yolk color. A total of 20 eggs were used as samples to be measured for quality and measurements were determined every 2 weeks during the trial period (weeks 54, 56, and 58). The degree of yolk pigmentation was observed with La Roche scale (Bovšková *et al.*, 2014). The contents of calcium in the egg were determined based on the methods described by AOAC (1995).

Data were subjected to analysis of variance, and means were compared by Duncan's multiple range test at a significan level of p (< 0.05). Statistical analysis was performed using SAS version 9.0.

RESULTS AND DISCUSSION

Production Performance and Nutrient Retention

Our study demonstrated that treated diets had no significant effect (P>0.05) on feed consumption. However, significant effects (P<0.05) were detected on hen day production, egg weight, FCR, egg mass production, protein and calcium retentions (Table 3). The use of 3% and 6% DSM resulted in similar egg production, protein and calcium retention as that in the control. This means that durian seed meal can be formulated up to 6% in laying hens diet without adverse effects on feed intake, nutrient digestibility and egg production. However, protein and calcium retention decreased with inclusion of 9% DSM which resulted in reduced egg production and egg weight. Egg weight at 6 and 9% DSM was significantly lower than control and 3% DSM. This is in agreement with Sugiarto and

Table 2. Composition and Nutrient Content of the Experimental Diets

Ingredients (%)	Dietary treatment groups			
	T0	T1	T2	T3
Maize	43.0	40.0	37.0	34.0
Rice bran	18.0	18.0	18.0	18.0
Palm oil	0.50	0.50	0.50	0.50
Durian seed meal	0.00	3.00	6.00	9.00
Soybean meal	19.0	19.0	19.0	19.0
Fish meal	10.0	10.0	10.0	10.0
$CaCO_3$	3.50	3.50	3.50	3.50
Oyster shell	5.00	5.00	5.00	5.00
Mineral mix[1]	1.00	1.00	1.00	1.00
Total	100	100	100	100
Calculated nutrient contents:				
Metabolizable energy (kcal/kg)[2]	2,734	2,610	2,514	2,418
Crude protein (%)[3]	17.8	17.6	17.4	17.1
Crude fiber (%)[3]	4.44	4.33	4.25	4.15
Ether extract (%)[3]	6.32	6.19	6.07	5.94
Calcium (%)[3]	3.31	3.30	3.29	3.28
Phosphorus (%)[3]	0.63	0.68	0.66	0.65
Methionine (%)[4]	0.44	0.44	0.44	0.44
Lysine (%)[4]	1.10	1.10	1.10	1.10

[1]*Mineral mix contained (every 10 kg of diet) Ca 48%–50%, P 13%–15%, Fe 40,000 mg, Mn 27,500 mg, I 500 mg, Cu 2000 mg, Zn 25,000 mg, Vitamin B12 4.50 mg, Vitamin D3 500,000 mg*

[2]*Metabolizable energy was calculated based on a formula (Bolton 1967) as follows: 40.81 {0.87 [Crude protein + 2.25 crude fat + nitrogen-free extract] + 2.5}*

[3]*Analysis was conducted by the Laboratory of Nutrition and Feed Science, Faculty of Animal and Agricultural Sciences, Diponegoro University*

[4]*The values were calculated based on the table of the National Research Council (1994)*

Toana (2018) reported that the diets containing up to 10% DSM did not reduce feed consumption in broiler chickens. In contrast, Sardina (2015) observed that the use of 10% DSM significantly decreased feed consumption and body weight gain in quails. These data suggest that different types of poultry have different capacity to digest.

The present study also indicated that the antinutritional factors (CFA and oxalic acid) in DSM diets had no adverse effects on the feed consumption of laying hens. This implies that laying hens were tolerant to cyclopropenoic and oxalic acids at the levels of 0.0567% and 0.0342% respectively.

Egg production and protein retention were affected by the treatments. The higher the levels of DSM, the lower egg production and protein retention were performed by laying hens. This is directly associated with protein availability for egg development. The availability of the main

Table 3. Performance and Nutrient Retention in Laying Hens Fed Diets containg Durian Seed Meal

Items	Dietary treatment groups			
	Control	3% DSM	6% DSM	9% DSM
Feed consumption (g/bird/day)	107 ± 5.3	105 ± 4.3	101 ± 5.8	103 ± 3.9
Hen day production (%)	64.29 ± 0.72[a]	61.19 ± 0.67[a]	60.36 ± 0.62[a]	46.67 ± 0.59[b]
Egg weight (g)	63.54 ± 0.62[a]	65.75 ± 0.68[a]	57.08 ± 0.58[b]	58.73 ± 0.61 [b]
FCR	2.62 ± 0.02[a]	2.61 ± 0.02[a]	2.93 ± 0.19[b]	3.75 ± 0.11[c]
Egg mass production (g/bird/day)	40.85 ± 0.13[a]	40.19 ± 0.83[a]	34.45 ± 1.30[b]	27.42 ± 1.36[c]
Protein retention (g)	13.7 ± 0.82[a]	13.17 ± 0.32[a]	12.3 ± 0.57[a]	11.4 ± 0.39[b]
Calcium retention (g)	3.03 ± 0.13[a]	3.04 ± 0.09[a]	2.97 ± 0.12[a]	2.87 ± 0.09[b]

[a,b]Values within the same row with different superscripts indicate significantly difference (P<0.05).

nutrients for egg synthesis is determined by the absorption rate of nutrients, especially proteins and calcium. The results of the present study were in agreement with findings of Rao and Reddy (2016), Adeyemo *et al*. (2012), Roberts *et al.* (2007) and Novak et al., (2006) who also reported a decrease in egg production with reduction in dietary crude protein level, which might be due to decreased of one/more amino acid required during particular laying period.

Decreasing protein digestibility due to administration of durian seeds causes low absorption of amino acids, which led to reduce daily egg production (HDP). The higher the level of durian seed meal, up to 9% the more it decreases calcium retention, which affects the weight of the eggshell and the level of egg protein. This is due to the content of antinutritional factors in the form of CFA and oxalic fatty acids after the boiling and drying process in durian seeds. The oxalate content can bind to calcium to form salts in the form of calcium oxalate which cannot be absorbed, thus inhibiting calcium absorption, thus causing the availability of calcium in the body to decrease. Additionally, the other anti-nutritional factors or the combination of fiber types may contribute to egg production. Durian seed contains polysaccharide gels and affects nutrient utilization (Amin *et al.*, 2007). The nature and content of fiber in the tested ingredient and the diet are a major determinant factor of nutrient utilization (Ojewola *et al.*, 2006). Based on the total feed consumption and the contents of oxalic acid in the diets, the daily oxalic acid intake (DOI) may be predicted as 0, 12.0, 23.1, and 35.1 mg/bird/day in control, 3% DSM, 6% DSM and 9% DSM, groups, respectively. Similarly, the daily cyclopropenoic acid intakes (DCI) were 0, 19.8, 38.3, and 58.3 mg/bird/day. Thus, we may say that both the low egg production and egg weight in T3 group were affected by low calcium absorption and decreased protein digestibility. Overall, this study shows that feeding diets containing up to 6% DSM did not find any detrimental effects on nutrient retention and egg production.

Egg Quality

Egg quality parameters are presented in Table 4. Egg shell weight, egg content weight, egg protein weight and egg protein mass, shell calcium content and shell calcium mass were different (P<0.05) as a result of DSM levels. However, egg calcium both percentage and mass as well as yolk color did not differ due to the treated diets. Improved egg content weight (2.8 g) and shell calcium 1%) were observed in 3% DSM inclusion compared to the control. This could be associated with the higher protein and calcium retentions (Table 3). And further increase in durian seed meal level (6% DSM)) provide beneficial effects on egg shell weight, shell calcium percentage and shell calcium mass. Nevertheless, most of egg quality parameters decreased (P<0.05) when the inclusion level was added to 9%. Therefore, using durian seeds in rations between 3 and 6% is considered to be appropriate levels for laying hen diets.

Table 4. The Qualities of Eggs from Laying Hens Fed Diets Containing Durian Seed Meals

Items	Dietary treatment groups			
	T0	T1	T2	T3
Eggshell weight (g)	8.00 ± 0.71[a]	7.20 ± 0.84[b]	7.40 ± 0.89[b]	7.40 ± 0.89[b]
Egg content weight (g)	56.1 ± 0.51[a]	58.9 ± 0.56[a]	49.7 ± 0.52[b]	51.3 ± 0.54[b]
Egg protein content (%)	10.4 ± 0.12[a]	9.91 ± 0.13[a]	10.0 ± 0.11[a]	9.46 ± 0.09[b]
Egg protein mass (g)	5.85 ± 0.45[a]	5.83 ± 0.51[a]	4.99 ± 0.51[b]	4.85 ± 0.55[b]
Shell calcium content (%)	40.1 ± 5.29[a]	41.1 ± 2.83[a]	42.4 ± 2.13[a]	38.7 ± 2.28[b]
Shell calcium mass (g)	3.22 ± 0.68[a]	2.96 ± 0.43[a]	3.12 ± 0.34[a]	2.86 ± 0.48[b]
Calcium content of eggs (%)	0.10 ± 0.01	0.09 ± 0.01	0.10 ± 0.02	0.10 ± 0.01
Calcium egg mass (mg)	55.8 ± 6.33	50.9 ± 7.56	47.4 ± 9.73	50.5 ± 6.56
Yolk color score	6.40 ± 0.31	6.10 ± 0.39	6.20 ± 0.32	6.40 ± 0.38

[a,b]Values within the same row with different superscripts indicate significantly difference (P<0.05).

The use of DSM in laying hens did not affect calcium content and calcium mass (P>0.05). Vargas-Rodríguez *et al.*(2016) confirmed that the calcium content of the feed did not affect the deposition of calcium in albumen. Yolk color was also not affected by the DSM diets. It is a well-known fact that the most interest concerning egg quality is yolk color. Carotenoid levels are responsible for yolk pigmentation (Nys, 2000; Kotrbáček *et al.*, 2013) and the common color pigment source in poultry diets is maize (Odunitan-Wayas *et al.*, 2016). In this context, the 9% DSM showed similar yolk score as the control (6.4) that is light color. Since the 9% DSM diet have similar basal diet except the level of DSM which contained 34% yellow corn indicating that DSM can replace yellow corn at 9% whilst maintaining light yolk colors and would be apposite consumer's demand. Thus, it can be suggested that DSM for laying hens inclusion greater than 6% DSM is not recommended.

CONCLUSIONS

Durian (*Durio zibethinus* Murr) seed meal may be used as an alternative ingredient for laying diets. The highest egg production and the heaviest egg weight were observed at the control group and 3% inclusion level of Durian seed meal (DSM) respectively. Similar tendency was also observed in protein and calcium retention.. When the inclusion level of DSM was increased (6%), production performance and egg qualities were declined except egg weight and the lowest was at 9% DSM. Inclusion levels of DSM up to 6% in laying hens were appropriate for expected performance, nutrient retention and egg qualities.

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