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Soy-Milk Waste with Soybean Meal Dietary Substitution: Effects on Growth Performance and Meat Quality of Broiler Chickens

Penggantian Bungkil Kedelai dengan Ampas Susu Kedelai dalam Pakan: Pengaruhnya pada Kinerja Pertumbuhan dan Kualitas Daging Ayam Broiler

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ABSTRACT

Sixty male broiler chickens was used to investigate the effects of dietary soybean meal (SBM) with soy-milk waste (SMW) substitution using growth performance, protein-energy efficiency ratio, and physical meat quality as response criteria. The birds were given control diet (SMW-0), or a control diets with 5% (SMW-1), 10% (SMW-2), and 15% (SMW-3) soy-milk waste substitutions. Each treatment was replicate 3 times, with 5 birds per replication. The obtained data were subjected to Oneway arrangement of ANOVA, and continued subsequently with Duncan's new Multiple Range Test. Results showed that substituting SBM with SMW did not influence protein and energy consumption, as well as feed consumption and energy efficiency ratio. However, dietary substitution with 10% SMW improved ($P<0.05$) protein efficiency ratio, body weight gain, and slaughter weight, resulting in lower ($P<0.05$) feed conversion ratio. The meat pH, water holding capacity, cooking loss, and tenderness values did not influence by 5-15% SMW substitution.

Keywords: broiler chickens, growth performance, physical meat quality, soybean meal substitution, soy-milk waste

ABSTRAK

Enam puluh ekor ayam broiler jantan digunakan untuk mengetahui pengaruh penggantian tepung bungkil kedelai (SBM) dengan ampas susu kedelai (SMW) dengan menggunakan kinerja pertumbuhan, rasio efisiensi protein-energi, serta kualitas fisik daging sebagai respon kriteria yang diamati. Ayam mendapatkan pakan kontrol (SMW-0), atau pakan kontrol dengan penggantian ampas susu kedelai sebanyak 5% (SMW-1), 10% (SMW-2), dan 15% (SMW-3). Setiap perlakuan diberikan replikasi 3 kali, masing-masing dengan 5 ekor ayam per replikasi. Data yang diperoleh selanjutnya dianalisis statistik menggunakan Oneway ANOVA, yang dilanjutkan dengan Duncan's new Multiple Range Test. Hasil penelitian menunjukkan bahwa penggantian SBM dengan SMW tidak mempengaruhi konsumsi protein dan energi, konsumsi pakan, maupun rasio efisiensi energi. Akan tetapi, penggantian 10% SMW meningkatkan ($P<0,05$) rasio efisiensi protein, pertambahan bobot badan, dan bobot potong ayam, sehingga nilai konversi pakan turun ($P<0,05$). Nilai pH daging, daya ikat air, susut masak, maupun keempukan daging tidak terpengaruh oleh penggantian 5-15% SMW.

Kata Kunci: ampas susu kedelai, ayam broiler, kinerja pertumbuhan, kualitas fisik daging, penggantian bungkil kedelai

INTRODUCTION

In recent years, mid-quality broiler chicken breeds (such as: New Lohmann) that raised in developing South-east Asia countries were normally harvested at body weight 1.5-2.0 kgs within 5-6 weeks. Whereas, hyline broiler chickens breeds (such as: Ross 308, Ross 708, or Cobb 500) in European countries and the United States can be harvested at weight 4.2-5.0 kgs within 9 weeks (Aviagen, 2007; Aviagen, 2014; Cobb-Vantress, 2015). Nowadays, good quality broiler chickens have very low feed conversion rate, high growth rate, and less costly nutrition. The fast growth of this

meat-type chickens is supported by superior quality feed stuffs which contain high quality nutrients and energy that provided in proper amount.

Protein and amino acids which needed for daily requirements were currently supplied by conventional protein source feed stuffs, such as: soybean meal (SBM). As a by-product in soybean oil industry, SBM contains not only high level of crude protein and digestible amino acids, but also is a good energy source for broiler chickens (Meng and Slominski, 2005). However, price of this commercial imported soybean meal becomes higher when the monetary crises happens or when the national supply is low. Alternative locally available low-priced feed stuffs should be explored to change over the position of conventional high-priced poultry feedstuffs. One of the alternatives that need to be investigated is soy-milk waste (SMW). SMW might be a useful candidate as this by-product in soy-milk industry contains high quality of nutrients (O'toole, 1999), which in turn will be beneficial in improving quality of meat yield. There is a high trend in SMW availability in the next couple of years due to the increase of soybean consumption and import (Aimon and Satrianto, 2014). A study must be done to explore the benefits of soybean meal dietary substitution with soy-milk waste using protein-energy efficiency, growth performance, and meat quality.

METHODS

Birds, Housing, and Experimental Design

This study was carried out in an opened-house poultry shed at the Faculty of Animal Science, Universitas Gadjah Mada, Yogyakarta. Sixty day old New Lohmann male broiler chickens were assigned into 4 dietary treatments in a complete randomized fashion. Each dietary treatment was given 3 replicate pens, with 5 birds in per replicate pen. The four treatments were a yellow maize basal diet that was formulated to meet all nutrient-energy requirements recommended by the breeder (SMW-0; control). Soybean meal in the treatment diets was substituted with soy-milk waste (SMW) in different doses: 5% (SMW-1), 10% (SMW-2), and 15% (SMW-3). Each treatment was replicated 3 times, with 5 birds in each replicate pen. The diets were formulated to meet the recommendations of the National Research Council (1994) for broiler chickens. The ingredients and chemical compositions of the diets are presented in Table 1. All of the diets for each period were prepared with the same batch of ingredients. Feed and drinking water were provided for ad libitum consumption.

Chicks were kept in floor pens (50 cm x 100 cm) equipped with a long feeder, bell drinkers, and brooder lamps. No coccidiostat, antibiotics, or enzymes were added to the experimental diets. The chicks were regular vaccinated at the hatchery against Infectious Bursal Disease, and no additional vaccinations were given during the study.

Sampling Procedures

Growth performance data were presented as feed consumption, slaughter weight, average daily gain, and feed conversion ratio (FCR). Feed consumption and slaughter weight data were taken on d 0 and 42 for calculation of body weight gain and FCR. The values of Protein and energy efficiency were presented as protein intake, energy intake, efficiency ratio (PER), and energy efficiency ratio (EER). According to the calculation done by Dono (2012), PER (g/g) were calculated by dividing body weight gain (g) with protein intake (g) at the same duration of rearing period. EER (g/100 kcal) were calculated by multiplying body weight gain with 100, and followed by dividing the result with gross energy intake (kcal).

On day 42, two birds per replicate pen with body weight similar to the mean body weight of the pen were killed by humane slaughtering on anterior part of the neck using very sharp blade according to Islamic Law. The samples of breast meat were removed and the meat quality traits were determined as meat pH, water holding capacity (Hamm, 1972), cooking loss, and tenderness (Bouton et al., 1971).

Table 1. Ingredient composition (g/kg, as-fed basis) and calculated nutrient and energy content of the diets used in the study.

Item	Dietary treatments[1]			
	SMW-0	SMW-1	SMW-2	SMW-3
Ingredients composition, %				
Yellow maize	48.75	48.50	48.85	48.85
Rice bran	17.17	17.16	16.58	16.04
Poultry meat meal	7.50	7.05	6.98	7.52
Fish meal	6.25	7.13	7.68	7.68
Soybean meal	15.00	10.00	5.00	0
Soy-milk waste	0	5.00	10.00	15.00
Palm kernel oil	2.10	2.10	1.94	1.95
Vitamin-mineral premix	2.50	2.50	2.50	2.50
Common salt	0.73	0.56	0.47	0.46
Total	100.0	100.0	100.0	100.0
Calculated Nutrients and Energy				
Metabolizable energy, kcal/kg	3057.4	3053.1	3034.7	3039.0
Crude protein, %	21.21	21.18	21.12	21.09
Crude fibre, %	3.05	3.22	3.30	3.41
Extract ether, %	4.60	4.90	4.92	4.96
L-Lysine, %	1.13	1.19	1.20	1.21
DL-Methionine, %	0.38	0.40	0.45	0.48
Calcium, %	0.77	0.79	0.83	0.86
Available Phosphorus, %	0.50	0.52	0.53	0.54

Note: Soybean meal substitution with 0% (SMW-0), 5% (SMW-1), 10% (SMW-2), 15% (SMW-3) soy-milk waste.

Statistical Analyses

Statistical analyses were conducted with the Statistical Package for Social Science (SPSS for Windows Version 15; SPSS GmbH, Munich, Germany) to determine if variables differed between groups. Growth performance, nutrient and energy utilization, as well as meat quality data between groups were analyzed statistically by Oneway ANOVA. Duncan's new Multiple Range Test was used to separate means with significant different (Steel and Torrie, 1993). Significance was declared at probability values of less than 5% ($P<0.05$).

RESULTS AND DISCUSSION

Results in current study showed that SBM substitution with 5-15% SMW did not affect protein and energy intake, energy efficiency ratio, as well as the amount of feed consumed by the birds. However, results on Table 2 showed that 10% SMW substitution increased ($P<0.05$) slaughter weight and average of daily weight gain by 1.79% and 3.53% improvements, respectively, resulting in a lower feed conversion ratio ($P<0.05$). The improvements on growth performance, as shown in the better average of daily gain (ADG) and slaughter weight, could be attributed to the increased in protein efficiency ratio (Table 3). Protein efficiency ratio (PER) – efficiency in the use of protein that daily consumed – shows the contribution of dietary protein intake in improving ADG (Dono, 2012). Therefore, results clarify that the lower dietary protein intake in combination with the higher value of ADG, the higher value of PER. As daily intake of protein is required and influential for growth and body enlargement, value of PER shows the effectiveness of protein in the diet for maximizing body development.

Table 2. Growth performance responses of broiler chickens to soy-milk waste substitution[1].

Variable	Dietary treatments[2]				Significance level	
	SMW-0	SMW-1	SMW-2	SMW-3	SED	p-value
Feed intake, g/bird	2822.2	2827.1	2836.2	2841.0	7.977	0.288
Average daily gain, g/bird	1487.2[b]	1495.4[b]	1513.8[a]	1524.6[a]	16.588	0.016
Slaughter weight, g/bird	1604.6[b]	1604.8[b]	1661.2[a]	1663.8[a]	30.276	0.026
Feed conversion ratio	1.898[a]	1.891[a]	1.874[b]	1.864[b]	0.016	0.013

[ab]Means within a row without a common superscript differ significantly ($P < 0.05$).
[1]Data represent means from 3 replicates pens of 5 birds per treatment.
[2]SMW-0=basal diet with 150% SBM (control; C), SMW-1=C with 5% SBM substitution, SMW-2= C with 10% SBM substitution, SMW-3=C with 15% SBM substitution.

Table 3. Energy and protein efficiency ratios of broiler chickens which receiving diets substituted with soy-milk waste[1].

Variable	Dietary treatments[2]				Significance level	
	SMW-0	SMW-1	SMW-2	SMW-3	SED	p-value
Energy Intake, kcal/bird	8629.86	8629.91	8630.91	8632.86	38.229	0.280
Protein Intake, g/bird	598.54	598.81	598.91	599.41	4.847	0.229
Energy Efficiency Ratio	17.233	17.329	17.540	17.660	0.201	0.111
Protein Efficiency Ratio	2.485[b]	2.497[b]	2.528[a]	2.543[a]	0.034	0.023

[1]Data represent means from 3 replicates pens of 5 birds per treatment.
[2]SMW-0=basal diet with 15% SBM (control; C), SMW-1=C with 5% SBM substitution, SMW-2= C with 10% SBM substitution, SMW-3=C with 15% SBM substitution.

Although the SBM substitution with 10% SMW reduced crude protein content, but the lysine and methionine contents of the diet SMW-2 were increased (Table 1). This might be due to the higher lysine and methionine contents of SMW than those of SBM (Forster *et al*., 2002). Substitution of SBM with SMW in current study therefore increased the content and availability of essential amino acids in the experimental diets. Improvement of essential amino acids content in the experimental diets might then increase the availability of micro nutrients which are required by the fast growing of the broiler chickens. This improvement might be the answer on why replacement of SBM with SMW with the level of 10% resulted in lower FCR and higher average daily gain and slaughter weight.

Results in this study were in accordance with the results of Hickling *et al*. (1990) that showed addition of diets with proper levels of methionine and lysine improved body weight gain and feed efficiency of 3-6 weeks old male Ross x Arbor Acres broiler chickens. Han and Baker (1994) with the same breed of broiler chickens also showed that increased of methionine and lysine levels in the corn-soybean meal basal diets had correlative effect with body weight gain and feed efficiency improvements. It has been shown in Labadan, Jr. *et al*. (1991) study that lysine requirement, as percentages of total amino acid in the diet, for maximum breast muscle growth were: 1.32 ± 0.01% (0 to 2 wk of age), 1.21 ± 0.06% (2 to 4 wk of age), 0.99 ± 0.02% (3 to 6 wk of age), and 0.81 ± 0.01% (5 to 8 wk of age), while lysine content of the experimental diets in current study was 1.13-1.21%.

More over, data in Table 4 showed that no reductions were shown in meat pH, water holding capacity, cooking loss, as well as the meat tenderness. SBM substitution with the rate of 5-15% SMW did not show any anfavorable effect on meat physical quality. Feedstuffs containing high levels of fiber may be a good source of bio-active substances that may contribute to maximize growth performance and meat quality of broiler chickens. On the other hand, high fiber level in the diet can also have a minor effect on broiler performance. A study using

Table 4. Meat physical quality responses of broiler chickens at 35 days of age in response to soy-milk waste substitution[1].

Variable	Dietary treatments[2]				Significance level	
	SMW-0	SMW-1	SMW-2	SMW-3	SED	p-value
Meat acidity (pH)	5.807	5.710	5.743	5.753	0.091	0.694
Water holding capacity	54.202	55.231	60.348	44.498	8.647	0.138
Cooking loss	27.389	29.775	29.737	33.319	4.344	0.474
Meat tenderness	1.893	1.593	2.267	2.243	0.717	0.697

[1]Data represent means from 3 replicates pens of 5 birds per treatment.
[2]SMW-0=basal diet with 15% SBM (control; C), SMW-1=C with 5% SBM substitution, SMW-2= C with 10% SBM substitution, SMW-3=C with 15% SBM substitution.

high-fibre containing feedstuff (Maurão *et al.,* 2008) showed that incorporating significant level of citrus pulp or dehydrated pasture in the diets reduced growth performance and meat characteristics of broiler chickens. However, Tabook *et al.* (2006) reported that dietary addition of date fibre had no significant effect on carcass or meat quality characteristics. In this study, substitution of SBM with 10% SMW increased crude fibre content of the diets but did not give any undesirable effect on physical meat quality responses. The lack of adverse effects on physical quality of meat might show that SMW can be used as alternative for SBM in the diets of broiler chickens.

CONCLUSSION

Soybean meal substitution in the diets with 10% soy-milk waste might have beneficial effects in maximizing efficiency in protein utilization and growth performance, without any adverse effects on meat quality of broiler chickens.

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