Buletin Peternakan 47 (2): 91-95, May 2023

ISSTAP
Indonesian Society for Sustainable Tropical Animal Production

Bulletin of Animal Science

ISSN-0126-4400/E-ISSN-2407-876X Accredited: 230/E/KPT/2022
http://buletinpeternakan.fapet.ugm.ac.id/

Doi: 10.21059/buletinpeternak.v47i2.78185

Substitution Effect of Rice Bran with Coffee Pulp Meal on Feed Efficiency and Percentages of Viscera Organs of Broilers

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Article history
Submitted: 4 October 2022
Accepted: 18 April 2023

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ABSTRACT

Research on animal feed has often focused on finding alternative feed ingredients to replace conventional ones in order to reduce feed costs. By-products from processing crops and food products have received much attention as feed alternatives because of their consistent and mass production, one of them is a waste of coffee. This research was conducted to evaluate the substitution effect of rice bran with coffee pulp meal on feed efficiency and viscera organs of broiler. The 100 broilers (Hubbard strain) and placed randomly into 4 treatments (R_0 = ration with rice bran 21% + 0% coffee pulp meal; R_1 = ration with 14% rice bran + 7% coffee pulp meal; R_2 = ration with 7% rice bran + 14% coffee pulp meal; R_3 = ration with 0% rice bran + 21% coffee pulp meal and each treatment consisted of 5 replications, five broilers each. The broilers were arranged by completely randomized design; a Tukey test was used to compare mean different of the treatments. Substitution effect of rice bran with coffee pulp meal on ration had significant effect on decreasing feed efficiency and significantly increase the weight percentage of heart, gizzard, pancreas, and intestine ($P<0.05$) but had no significant on the weight percentage of caecum in broiler ($P>0.05$) Tukey test showed that the higher proportion of coffee hull meal the feed consumption and body gain non-significant to R_0, R_1 and R_2. On the other hand, feed efficiency of R_3 significantly lower compared to R_0, R_1 and R_2. The higher the percentage of liver, gizzard, pancreas and intestine weight. However, there was no significant effect on caecum weight percentage. The conclution was: Utilization coffee pulp meal had significant effect on decreasing feed efficiency and significantly increase the weight percentage of heart, gizzard, pancreas, and intestine.

Keywords: Coffee pulp meal, Feed efficiency, Rice bran, Tannin, Viscera organs

Introduction

Provision of feed raw materials is a factor that determines the success of a livestock business. Appropriate use of relatively inexpensive agricultural and industrial by products is of paramount importance for profitable livestock production and to reduce competition for human food (Negesse *et al.,* 2009). More over, the worldwide food, agricultural and forestry industries produce annually large volumes of wastes, which cause serious disposal problem (Rodríguez, 2008).

The coffee shell or pulp is the first by-product obtained from the processing of coffee. The nutritional value of waste and by-products of coffee has been studied by several researchers. Waste and by-products of coffee generally contains contained 6.67% of crude protein, 18.28% of crude fiber, 1.0% fat, 0.21% calcium and 0.03% phosphorus (Londra, 2007). Coffee pulp is an abundant agricultural by-product represents around 43% of the weight of the coffee fruit on a fresh weight basis, or approximately 28% on a dry weight basis. This Coffee pulp is essentially rich in carbohydrates, proteins and minerals (especially potassium) and it also contains appreciable amounts of tannins, polyphenols and caffeine (Deligiannis *et al.,* 2016).

Use of feed ingredients high in dietary fiber in poultry nutrition has generally been discouraged due to the negative effects exerted on nutrient utilization and performance such as decrease in body weight gain and feed conversion (Walugembe, 2013). On the other hand, this case might increase the activity of gizzard, lung and heart of animal poultry causing enlarged structures of these organs. Birds increased their metabolism ability to digest crude fiber and consequently cause sizes of gizzard, lung, and heart (Hetland *et al.,* 2005). Coffee pulp meal can be used as an alternative feed for chicken livestock, the high fiber content is likely to affect the efficiency of using feed as well as viscera organ components of chickens. Therefore, the research was conducted to evaluate the substitution effect of

rice bran with Robusta coffee pulp meal on the efficiency of feeding and viscera organs.

Materials and Methods

Animal and management. Total 100 broilers Hubbard strain were tested in completely randomized design. Using an open system cage. The broilers cages used were bateray cages measuring 30x35x35 cm 100 units, the temperature of the cage ranged from 27-29^{0}C. Feed and drinking water are provided ad libitum.

Experimental diets. The diet consists of four treatments were rice bran based ration: R_0 = rice bran 21% + 0% coffee pulp meal; R_1 = rice bran 14% + 7% of coffee pulp meal; R_2 = rice bran 7% + 14% of coffee pulp meal; R_3 = rice bran 0% + 21% of coffee pulp meal. Nutrient compositions of ration ingredients were presented in Table 1. Based ration of the treatments consisted of yellow corn, coconut meal, fish meal and soybean meal. The coffee pulp meal used in this study was obtained from coffee bean processing waste at the "Kotamobagu" Coffee meal manufactory in Kotamobagu city North Sulawesi. The waste in the form of coffee pulp is shown in (Figure 1a) which is processed into coffee pulp meal (Figure 1b).

Figure 1a. Coffee pulp.

Figure 1b. Coffee pulp meal.

Measurements

The variables measured in this study included daily feed intake (g/chick); weight daily gain (g/chick); and feed efficiency percentage (is calculated as weight gain divided by feed intake).

The viscera organs measured included the weight percentage of the liver, gizzard, pancreas, intestines and caecum. The calculation is as the percentage of Viscera organs weight (liver, gizzard, pancreas, intestine and caecum) relative to live weight, according to the formula: PV (%) =VW/CW*100. (PV= percentage of viscera organ (liver, gizzard, pancreas, intestine and caecum); VW=Viscera organs weight (liver, gizzard, pancreas, intestine and caecum); LW=Live weight (Hafsan *et al.,* 2019; Badaruddin *et al.*, 2022).

Data analysis

The treatmens were arranged in a Completely Randomized Design research with 4 treatments and 5 replications. The Honestly Significantly Difference (HSD) was used to test the significant difference among treatments (Steel and Torrie, 1991).

Results and Discussion

The variables observed in this study were feed consumption, body weight gain, feed efficiency and the percentage of viscera organs of broiler chicken are presented in Table 2. The effects of substitution rice bran with coffee pulp meal on feed efficiency and percentages of viscera organs of broiler are presented in Table 2.

Feed consumption, weight daily gain and feed efficiency of broiler

Feed consumption in this study was ranging from 68.55 to 109.93 g (Table 2). The average of the highest feed consumption was obtained on treatment with 21% rice bran and 0% coffee pulp meal and the lowest in treatment using 0% rice bran and 21% coffee pulp meal. Analysis of variance showed that utilization of coffee pulp meal in ration affected significantly ($P<0.05$) the feed consumption.

It showed that the coffee pulp meal up to 21% dereased feed intake. The HSD test indicated that treatments of R_0, R_1, R_2 and R_3 significantly different ($P<0.05$). Weight daily gains of broiler in this study were ranging 22.12 to 47.55 g/chick (Table 2). The average of the highest weight daily gain of broiler was obtained on treatment with a 21% rice bran and 0% coffee pulp meal and the

Table 1. Nutrient compositions of ration ingredients of the treatments (%)

Ingredients	R_0	R_1	R_2	R_3
Yellow corn*	46.50	46.50	46.50	46.50
Soybean meal*	13.00	13.00	13.00	13.00
Coconut meal*	5.00	5.00	5.00	5.00
Fish meal*	14.00	14.00	14.00	14.00
Rice bran*	21.00	14.00	7.00	0.00
Coffee pulp meal*	0.00	7.00	14.00	21.00
Top mix	0.50	0.50	0.50	0.50
Total	100.00	100.00	100.00	100.00
Nutrient percentage (%)				
Protein	21.13	21.20	21.26	21.33
Fat	6.46	6.48	6.49	6.50
Crude fiber	6.67	6.91	7.14	7.38
Calsium	0.88	0.89	0.90	0.91
Phosphor	0.97	0.88	0.79	0.70
Metabolic energy (Kcal/kg) **	3064.73	3054.02	3043.31	3032.60

*Calculated on the bases of laboratory analysis in Feed and Nutrient Laboratory–IPB (2010); **ME=Calculated metabolizable energy.
R_0=rice bran 21%+0% coffee pulp meal; R_1=rice bran 14%+7% of coffee pulp meal; R_2=rice bran 7%+14% of coffee pulp meal; R_3=rice bran 0%+21% of coffee pulp meal.

Table 2. Averages of the feed consumption, daily gain, feed eficiency and organ percentages in broiler

Variable	R_0	R_1	R_2	R_3
Feed consumption (g)	109.93±1.52[a]	99.30±1.67[b]	84.69±0.50[c]	68.50±3.24[d]
Daily gain (g)	47.55±1.86[a]	37.78±1.66[b]	32.11±1.82[b]	22.12±1.17[c]
Feed eficiency (%)	0.43±0.01[a]	0.38±0.01[a]	0.38±0.02[a]	0.32±0.01[b]
Liver (%)	1.84±0.10[a]	1.87±0.15[a]	2.32±0.14[a]	3.03±0.14[b]
Gizzard (%)	1.96±0.10[a]	2.26±0.13[ab]	2.45±0.14[ab]	2.66±0.18[b]
Pancreas (%)	0.24±0.02[a]	0.24±0.04[a]	0.28±0.03[ab]	0.37±0.03[b]
Intestine (%)	2.42±0.36[a]	2.78±0.32[ab]	2.78±0.17[ab]	3.48±0.11[b]
Caecum (%)	0.77±0.14	0.66±0.12	0.80±0.09	1.12±0.29

[a,b,c,d] Means within the same row with different superscripts differ significantly (P<0.05).

R_0=rice bran 21%+0% coffee pulp meal; R_1=rice bran 14%+7% of coffee pulp meal; R_2=rice bran 7%+14% of coffee pulp meal; R_3=rice bran 0%+21% of coffee pulp meal.

lowest weight daily gain in treatment was the treatment using 0% rice bran and 21% coffee pulp meal. Analysis of variance showed that utilization of coffee pulp meal in ration affected significantly (P<0.05) the weight daily gain. It showed that the coffee pulp meal up to 21% replacing the rice bran in the ration decreased weight daily gain. The HSD test indicated that treatments of R_0, R_1, R_2 and R_3 significantly different (P<0.05). The treatment of R_0 was significantly higher than those of R_1, R_2 and R_3. The treatments of R_1 and R_2 were not significantly different in feed effeciency but significantly higher than treatment of R_3. HSD test showed that the higher the use of coffee pulp meal in the ration resulted in increasingly poor weight gain.

Feed efficiency of broilers in the study was ranging from 0.43 to 0.32 (Table 2). The average of the highest feed efficiency of broiler was obtained on treatment with a 21% rice bran and 0% coffee pulp meal and the lowest in treatment using 0% rice bran and 21% coffee pulp meal. Analysis of variance showed that utilization of coffee pulp meal in ration affected significantly (P<0.05) the feed efficiency. The HSD test indicated that treatment of R_0, R_1, and R_2 was significantly higher than treatments of R_3.

This case showed that utilization of coffee pulp meal was maximum at the level of 21% (R_3) causing reduced feed consumption on broiler. This was presumably caused by the fact that, although the nutrient content of the ration treatment was in the balance or almost in the same levels, but coffee pulp meal contains anti nutrients of tannin and caffeine. These anti nutritional factors can probably interfere with the utilisation of dietary nutrients, causing reducing in growth and feed efficiency (Huisman and Tolman, 1992).

The presence of tannins and caffeine diminish acceptability and palatability by animal (Mazzafera, 2002). According to Kumar and Singh (1991), reproted that tannin was binding the protein complex, causing the protein was difficult to be digested by the protease enzyme (Tandi, 2010), more difficult be digested in intestines (Preston and Leng, 1987), It was proposed by (Patra and Saxena, 2009) that condensed tannins in the diets reduced the amount of available hydrogen for methanogenesis, lowered releases of enteric methane to the atmosphere (Harrison *et al*., 2015), it is now important to take into account the utilization of agricultural waste or food by product as feed in the environmental aspect point of view.

The efficiency of using feed can be seen from the ability to convert feed into meat. Fahrudin *et al.* (2017) stated that the smaller the ration conversion value, the more efficient the livestock is in conversion of feed to meat. The higher the feed efficiency value, the better the use of ration. This was due to the less the use of ration by animals (Aggrey *et al*., 2010). This study yielded low feed efficiency under 50% by using coffee pulp meal substituting rice bran in ration. The study revealed that the use of coffee pulp meal substituting rice bran in ration must be less than 7%.

Viscera organs: liver, gizzard, pancreas, intestine, and caecum weight percentage of broiler

Liver weight percentages in this study were ranging from 1.84% to 3.03% from animal life weight (Table 2). Treatments of R_0, R_1 and R_2 produced normal liver weight of broiler ranging from 1.70% to 2.30% or 31 to 51 g (Siregar *et al*., 1980). According to Putnam (1991) reported that normal liver weights were 1.7 to 2.8 percents from animal life weight. Treatment of R_3 in this study produced the highest liver weight percentage of 3.03%. Analysis of variance showed that utilization of coffee pulp meal in ration increased significantly (P<0.05) the percentage of liver weight. The HSD test indicated that treatments of R_0, R_1 and R_2 were not significantly different (P<0.05). However, treatment of R_3 was significantly higher than treatments of R_0, R_1 and R_2, which results in high liver weight percentage, where according to Wandono *et al.* (2013), the average percentage of liver weight ranges from 2.04% to 2.15% of live weight.

Gizzard weight percentages in this study were ranging from 1.96% to 2.66% from animal life weight (Table 2). High weight percentahe of gizzard was found at the treatmen R_3 using 21% of coffee pulp meal in ration. Based on HSD test, it was indicated that treatment of control (R_0) was not significantly different (P<0.05) with treatments of R_1 and R_2. The treatment of R_2 was not significantly different with the treatment of R_3.

Pancreas weight percentages in this study were ranging from 0.24% to 0.37% from animal life weight (Table 2). Based on variance analysis, it was indicated that treatments of control (R_0), R_1 and R_2 were not significantly different. Intestine weight percentages in this study were ranging from 2.42% to 3.48% from animal life weight (Table 2). Results in this study were in agreement with

research reported by (Resnawati, 2010) ranging from 2.94% to 3.42%. Analysis of variance indicated that treatments affected significantly ($P<0.05$) the intestine weight. Based on HSD test, it was indicated that treatment of control (R_0) was not significantly different ($P<0.05$) treatments of R_1 and R_2. These two treatments of R_1 and R_2 were not significantly different with the treatment of R_3. Caecum weight percentages in this study were ranging from 0.66% to 1.12% from animal life weight as shown in Table 2 Analysis of variance indicated that treatments did not affect significantly ($P>0.05$) the caecum weight.

The substitution treatment for coffee pulp meal grounds 7% and 14% in this study was 1.96 to 2.36, these results were within the normal range of the weight percentage gizzards of poultry, which ranged from 1.6 to 2.3 (Hafsan *et al,* 2019). The higher the utilization of coffee pulp meal (21%) in rations, the higher the activity of animal internal organ. Studies using rat, chicks and other animals revealed that high tannins in diet adversely affected digestibility of proteins and carbohydrate in increasing metabolic activities in an effort on making up for the reduced availability of protein inhibited and increased activity of pancreas (Sotelo and Flores, 1995). Inclusion diet could probably be due to higher physiological activities by these organs triggered by the presence of antinutritional factors and their concomitant effects (Uchegbu *et al*., 2004). Gizzard of ventriculus has two strong parts of muscles not containing tissue excreting enzyme, but it palyed role to break feed into small particles, mainly feed containing high crude fiber (North and Bell, 1990). According to Natsir (2008), reported that weight of organ including liver, pancreas and spleen were affected by absobsion of nutrient and crude fiber. Pancreas was internal organ excreting enzymes used for digestion of protein, fat and carbohydrate. Increasing secretion of digestion enzymes was produced by pancreas, causing increase of pancreas weight (Pearce, 2005). The higher the utilization of coffee pulp meal (21%) in rations, the higher the weight of animal internal organ. This study indicated that utilization of coffee pulp meal did not affect caecum weight. This might be caused by the fact that large intestine generally play role as tract for liquid excretion (Rasyaf, 2002). The digestibility might occur in part of caecum due to exsistence of fermenting bacteria, but in the limited amount of this micro organisms might compare to another mammal species (Pond *et al*., 2005).

Conclusions

Utilization coffee pulp meal had significant effect on decreasing feed efficiency and significantly increase the weight percentage of heart, gizzard, pancreas, and intestine.

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