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Productivity and Meat Quality of Local Cattle Fed Soybean By-Products

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Abstract: The main problems behind low productivity of beef cattle raised by farmers in the villages are the less sufficiency of feed resources and low quality of feed available for the animals, especially the deficiency of protein/nitrogen and low feed intake. This study was aimed to improve the productivity of local cattle in Indonesia through the utilization of soybean meal and its wastes as the main protein source. Twelve heads of Madura cattle with an average initial live weight of 175.64±16.4 kg and ages between I_1-I_2 (18-30 months) were used in the study. The cattle were allotted into four feeding treatments i.e., T0 as control (100% native grass); T1 (40% roughage 60% concentrate); T2 (complete feed with 15% soybean pods) and T3 (complete feed with 30% soybean pods, for three months. The observed parameters included cattle performance (final weight, average daily gain, feed consumption and feed conversion), carcass quality (backfat thickness, loin eye area and meat color) and physical quality of meat (pH, water holding capacity, cooking loss and meat tenderness). The results showed that cattle fed soybean wastes (T1, T2 and T3) were higher in all variables of cattle performance and backfat thickness compared to those fed control feed. Utilization of feed combined with soybean waste could improve cattle performance with relatively better meat quality than those given grass only.

Key words: Cattle performance, meat quality, soybean waste

INTRODUCTION

Beef cattle are very potential commodity in Indonesia and should therefore be increased both in their numbers and productivity to meet the people's needs for meat. Indonesia's annual meat consumption in 2014 was 5.005 kg/capita/year (PKH DG, 2015), which was extremely low compared to that of ASEAN countries reaching 20-30 kg/capita/year. This condition was mainly caused by people's low purchasing power and high prices of meat products, so that policies and efforts to increase the population and productivity of beef cattle in Indonesia are urgently required. According to Khasrad and Ningrat (2010), domestic needs for meat will continue to increase along with the increase in human population, economic level, public awareness of nutrition and the presence of foreign people.

The low productivity of beef cattle reared by farmers in the rural areas of Indonesia is primarily due to the limited availability of feed resources and low quality of feed nutrients consumed by the cattle, especially protein/nitrogen. One strategy to improve the productivity of beef cattle is by providing adequate raw materials that are rich in protein, such as soybean meal and soybean waste. The utilization of agroindustrial by-products as animal feed has widely been implemented in Korea and Ghana (Ha *et al*., 2007; Dei, 2011). According to McDonald and Larivire (2002), soybean meal is rich in protein content (about 44% with balanced amino acids) and also energy and TDN (Sruamsiri and Silman, 2008). The replacement of some forages by soybean by-product had proven better cow performance based on milk production and quality (Weidner and Grant, 1994; Satter *et al*., 1994).

Currently, Indonesia is still depended on imports to meet the needed for soybean meal for animal, although Indonesia in fact has extensive agricultural areas which are potential to reach self-sufficiency in this sector for both, humans and livestock needs. Actually, the available marginal lands can also be utilized since soybean plants can adapt to a number of land types and environment. Moreover, applied technology can be used to improve the quality of maginal lands.

Utilization of soybean waste as beef cattle feed for fattening purposes is one of the alternative solutions to improve performance and feed efficiency. Kennedy *et al*. (2012) reported that the use of 15% soybean meal in ration combined with corn cobs is able to increase daily weight gain of sheep. Research findings on nutrient contents and the use of soybean and its by-products for dairy cattle are reported by Ishler and Varga (2009). This study aimed to evaluate the use of soybean pods in the ration on cattle productivity, feed efficiency, carcass quality and the quality of local beef cattle.

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MATERIALS AND METHODS

The experiment was conducted in the Field Laboratory of Large Ruminant, Faculty of Animal Science, Bogor Agricultural University for 8 month from April to November 2014 including preparation, feeding implementation and report writing.

Twelve Madura cattle with an average initial body weight of 175.64±16.4 kg were used in this study. Four feeding treatments were applied T0 (100% grass as control); T1: 40% roughage and 60% concentrate; T2 (complete ration with 15% soybean pods) and T3 (complete ration with 30% soybean pods). Cattle were kept in individual cages and fed different types of rations. The composition and nutritional quality of each feeding treatment is presented in Table 1 and 2. The rations were given *ad libitum* using feeding technique called bunk score system (Aditia *et al*., 2013). To obtain the weight, cattle were individually weighed once a month.

During the experimental period, one cattle given 40% roughage and 60% concentrate (T1) was eliminated due to a significant decrease in health condition.

Table 1: Feed formulation of each treatment (% Dry Matter)

	---------- Types of treatment (%) ----------			
Raw material of ration	T0	T1	T2	T3
Grass	100	40	-	-
Soybean pods	-	-	15	30
Concentrate	-	60	85	70
Cassava waste	-	21.0	20.0	10.0
Pollard	-	19.2	22.0	15.0
Soybean meal	-	3.0	5.0	7.0
Coconut meal	-	6.0	0.0	0.0
Molasses	-	9.0	15.0	15.0
$CaCO_3$	-	0.9	1.5	1.5
Urea	-	0.6	1.0	1.0
Tofu waste	-	-	20.0	20.0
Premix	-	0.3	0.5	0.5
Total	100	100	100	100

Table 2: Nutrients composition of feed used in each treatment

	---------- Treatment (% DM) ----------			
Nutrient composition	T0	T1	T2	T3
Dry mater	23.5	85.9	72.2	73.9
Crude protein	8.82	14.2	14	14.2
Total digestible nutrient	47.85	74.2	71	68

Procedures: The twelve local cattle were obtained from farmers and individually kept in the experimental units for 2 weeks adaptation period and 3 months for feeding treatments. Animals and all facilities were treated with sanitation procedures to avoid any contamination or health problems. Then, cattle were randomly chosen and individually put into animal units based on treatment allocation. Before the slaughter process took place, the cattle were given one day for fasting for 12 h to reduce the content of the digestive tract and urinary tract. The slaughter procedures referred to the Indonesian National Standard (SNI) No.3932/2008 (BSN 2008). The cattle were slaughtered by following the national standard and the animal welfare consideration. The process of carcass dressing was done by separating the head, the lower four legs, hide, taking out the organs in the body (offal), the reproductive organs and udder, tail, as well as excess fat (BSN, 2008).

Variables measured: The variables measured in this study included (a) cattle performance (final body weight, daily weight gain, feed intake and feed conversion); (b) carcass quality (backfat thickness, loin eye area and meat color) and © meat physical quality (pH, water holding capacity, cooking loss and meat tenderness).

Analysis of carcass Characteristics and meat quality: Carcass characteristics included backfat thickness, loin eye area and meat color and the meat quality based on physical properties included meat pH, water holding capacity, meat tenderness and cooking loss. The measurement of backfat thickness (mm) and loin eye area was done on the Longissimus dorsi muscle area located between the 12 and 13th ribs (BSN, 2008). Meat color was tested using a chromameter referring the procedure of Page *et al*. (2001). The measurement of water holding capacity referred to the method of Hamm (Soeparno, 2005), which was based on the percentage of the water excess (% mg H_2O). The measurement of meat tenderness was following the procedure of Warner-Bratzler Wheeler *et al*. (1994). Cooking loss was determined by measuring the weight loss of meat during the cooking process (Soeparno, 2005).

Experimental design and data analysis: This study used a completely randomized design with four feeding treatments with soybean waste substitution T0 (100% grass as control), T1 (40% grass and 60% concentrate), T2 (complete ration with 15% soybean pods) and T3 (complete ration with 30% soybean pods). The numbers of cattle used were twelve heads given four feeding treatments and 3 replication for each treatment. Data were analyzed using covariance analysis and presented in tables and figures. The average initial body weight was analyzed using co-variable factor (Kaps and Lamberson, 2004).

RESULTS AND DISCUSSION

Cattle performance and feed consumption: Performance of the local cattle based on each feeding treatment is presented in Table 3.

Based on data in Table 3, the types of ration used in this study affected the increase of final body weight, average daily gain, ration intake and feed efficiency. The performance of cattle given soybean waste-based rations (T1, T2 and T3) showed higher average final body weigh, daily gain and feed efficiency ($p<0.05$) than control ration (T0). The consumption of dry matters and

Table 3: Cattle performance based on feeding treatments

Variable	T0	T1	T2	T3
Initial body weight (kg)	177±28.62	171±1.41	176.33±15.14	176.67±16.44
average final weight (kg)	201.67±43.13^{b}	231.5±16.26^{a}	237±27.87^{a}	228±16.52^{a}
average daily gain (kg/day)	0.28±0.17^{b}	0.69±0.17^{a}	0.69±0.16^{a}	0.58±0.07^{a}
Feed consumption				
a. Dry mater	4.79±1.49^{b}	6.23±0.01^{a}	7.00±0.67^{a}	6.80±0.31^{a}
b. Crude protein	0.38±0.12^{c}	0.73±0.05^{b}	1.18±0.11^{a}	1.16±0.06^{a}
c. TDN	2.60±0.81^{c}	4.15±0.16^{b}	4.97±0.47^{a}	4.62±0.21^{a}
Feed efficiency	5.36±2.40^{c}	11.03±2.68^{a}	9.76±1.32^{ab}	8.62±1.42^{bc}

T0 (100% grass), T1 (40% grass and 60% concentrate), T2 (complete ration with 15% soybean pods) and T3 (complete ration with 30% soybean pods). DM: Dry matter; TDN: Total digestible nutrients

crude protein of cattle given complete ration with 15% soybean pods (T2) and 30% soybean pods (T3) were significantly higher ($p<0.05$) than those of other treatments and for energy consumption of cattle fed T2 showed a significantly higher values ($p<0.05$) than those given other treatments. These results indicate that based on all variables of feed consumption, T1, T2 and T3 were mostly preferred by animals which was consequently, able to contribute to the significantly higher growth performance. Undoubtedly, this type of feed resources could be used as one of the alternative choices of feeds to improve cattle productivity.

During the period of fattening, the average daily gain of cattle per treatment was simultaneously increased from the average initial body weight of 175 kg, with slightly differences found between treatments (Fig. 1). The response of cattle given complete feed and 15% soybean pods (T2) was similar with those fed 40% soybean pods (T3), due to the higher consumption of dry matter, crude protein and energy. This revealed that feed nutrients of T1 and T2 seemed to be similar and preferred by animals, in line with Field (2007), that one of the most important factors influencing the performance of livestock was the nutrients consumption. The nutritien composition and values of soybean pod was relatively high to contribute to cattle growth crude protein and TDN, reported by Sruamsiri and Silman (2008); the function of moisture content and energy by Azadbakht *et al*. (2012) and could be used as alternative feed sources.

The lower efficiency of grass feeding, was proportional with the lower feed consumption and cattle performance despite the feed cost as compared to other feeding treatments. According to Fig. 2 and 3, the ADG,s of cattle given soybean based rations were higher as compared to those given grass only, except the feed efficiency. The slight variations amongst treatments and periods might be associated with the different individual response of cattle to each treatments. Based on these results, soybean pods could be used as alternative source of feed for cattle, especially during the harvest time, when farmers can be helped to diversify feed and provide an alternative solution to solve the shortage of feed for cattle. Dei (2011), suggested that soybean and its

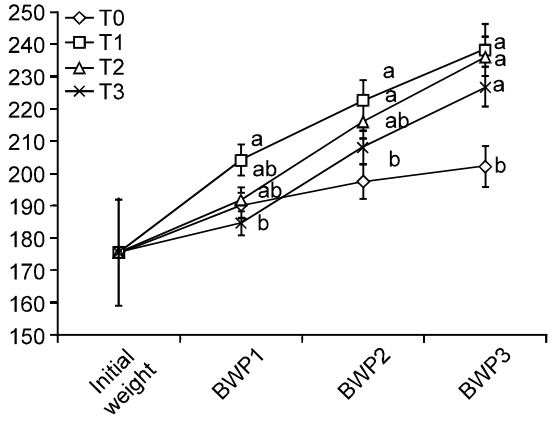

Fig. 1: Average daily gain of Madura cattle fed soybean-based rations. T0 (100% grass), T1 (40% grass and 60% concentrate), T2 (complete ration with 15% soybean pods) and T3 (complete ration with 30% soybean pods)

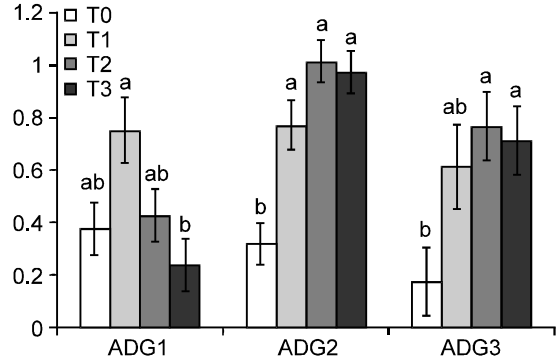

Fig. 2: Body Weight Gain of Madura cattle fed soybean-based rations. T0 (100% grass), T1 (40% grass and 60% concentrate), T2 (complete ration with 15% soybean pods) and T3 (complete ration with 30% soybean pods)

by-products were potential protein sources in animal feed industry with high palatability and availability with low cost. When other feed resources are limited during critical dry seasons, soybean pods which are rich in fiber could be used for animals through appropriate processing and good storage.

It is interesting to note (Fig. 2), that the body weight gain of cattle fed T2 and T3 showed higher body weight gain during the second and the third months than those fed T0 and T1. The weight gain was significantly increasing at the next fallowing periods, as compared to the results found at the first period of the study. This might be associated with the status of individual animals during the adaption period at the first month and the quick response of the groups of animals to feed given during the study period. The compensatory growth of cattle fed T2 and T3 were resulted from a quick adaptation of animals to feed and feeding management. Warriss (2000), stated that the acceleration of mass growth of cattle is due to different responses of individual animals to feeding management and nutrient composition of types of feed given. The preference of cattle to soybean waste-based diet affected the cattle performance, this indicates the rich attributes of the by-products. Dei (2011), suggested an extensive use of this feed source in livestock production.

Carcass characteristics and meat quality: The results of meat analysis of Madura cattle given soybean pods are presented in Table 4. Despite the supplementation obviously increased final body weight, carcass resulted from those treatments had similar backfat thickness compared to animal given control feed. Meanwhile, concentrate supplementation to the local cattle significantly increased final body weight and backfat thickness. The increase of backfat thickness was obviously influenced by the level of energy in ration. Cattle fed the combination of concentrate and soybean pods containing high level of energy consumed obviously more TDN compared to those fed the control ration (T0). Priyanto (2014), reported that a tendency of increased fatback thickness of Sumba Ongole (SO) cattle treated with higher level of energy in ration.

The local cattle fed 100% grass had similar characteristics of carcass and meat characteristics, including pH, tenderness, water holding capacity (WHC), cooking loss, loin eye area (LEA) and meat colour compared to those supplemented with concentrate or soybean pods. The values of pH resulted from this study was within the range of 5.3 and 5.5, of which at the ultimate pH level, as recommended by Buckle *et al.* (1987) and MLA (2013), that the normal pH levels of meat was between 5.3-5.7. Water holding capacity of meat is expressed in the amount of free water come out from the meat (% mg H_2O). The values of WHC and cooking loss of meat in this study lied between 43.8-53.1% and 22.5-31.6%, respectively and was similar in all feeding treatments. This values were considered normal at traditional moist cooking method.

Meanwhile, the values of meat tenderness was 2.5-4.6 kg/cm^2, categorized as tender meat according to Wheeler *et al.* (1994). Loin eye area was used as reliable indicator of carcass yield and the results showed no significant differences between treatments. The level of meat tenderness in this study ranged from 2.5 to 4.6, indicating that the meat produced belonged to the category of tender (Wheeler *et al.*, 1994). Several studies indicated that beef cattle kept intensively on concentrate based diet can have brighter meat color, if compared to those given roughage based (Dunne *et al.*, 2004; Nuernberg *et al.*, 2005). Nevertheless, the meat colors from Madura cattle fed on grass and concentrate based diets were similar.

Table 4: Characteristics of carcass and meat of Madura cattle fed soy-based rations

Variable	T0	T1	T2	T3
Final weight (kg)	202.04±6.3^b	238.18±7.8^a	236.00±6.3^a	226.52±6.3^a
Backfat thickness (cm)	0.150±0.07^b	0.350±0.07^a	0.200^{ab}	0.250±0.07^{ab}
Loin eye area (cm^2)	42.39±21.6	58.78±7.9	56.49±7.8	57.52±10.2
pH	5.395±0.02	5.510±0.37	5.320±0.72	5.475±0.04
Water holding capacity (% mgH_2O)	22.510±17.00	27.720±8.98	31.580±1.60	25.005±10.59
Tenderness (kg/cm^2)	4.635±1.46	3.265±2.21	2.480±0.64	4.385±1.53
Cooking loss (%)	43.795±6.84	45.850±2.32	53.105±9.48	50.425±2.69
Meat color				
a. Value of L	42.66±0.6	46.10±0.8	41.69±12.4	48.24±2.5
b. Value of a	21.94±1.9	18.47±4.1	21.04±3.2	21.32±1.1

T0 (100% grass), T1 (40% grass and 60% concentrate), T2 (complete ration with 15% soybean pods) and T3 (complete ration with 30% soybean pods)

Table 5: Feed intake, body weight gain and feed efficiency of Madura Beef Cattle given complete feed containing soybean pod

Variabel	T0	T1	T2	T3
Feed Intake (kg DM)	4.403±0.22^b	5.057±0.27^b	6.903±0.22^a	6.540±0.22^a
Final Body weight (kg)	202.04±6.3^b	238.18±7.8^a	236.00±6.3^a	226.52±6.3^a
Average daily gain (kg/day)	0.300±0.07^b	0.714±0.09^a	0.686±0.07^a	0.578±0.07^a
Feed efficiency (%)	6.27±1.3^b	14.45±1.6^a	9.84±1.3^{ab}	8.84±1.3^b

T0 = 100% native grass, T2 = concentrate: grass (60:40), 3. T3 = complete feed containing 15% soybean pods, 4. T4 = complete feed containing 30% soybean pods. The different superscripts in the same row represent there are significant difference ($p<0.05$)

Feed intake, daily gain and feed efficiency: The use of complete feed containing soybean pod 15 or 30% significantly increased ($p<0.05$) feed intake compared to the concentrate and control treatments. The use of concentrate ration and complete feed containing soybean pod 15 or 30% also significantly increased ($p<0.05$) feed efficiency, final body weight and average daily gain of Madura beef cattle compared to the control treatment (Table 5).

The increasing of feed intake with the use of complete feed containing soybean pods up to 30% indicating that soybean waste especially soybean pods had high palatability as beef cattle feedstuff. Although soybean pods had a dry texture, but did not have negative effect on feed consumption.

The improving of feed intake could increase feed efficiency, body weight gain and average daily gain of Madura beef cattle given complete feed containing soybean pods similar with those given concentrate ration. This results indicate that complete feed containing soybean pods could improve the performance of Madura beef cattle as good as concentrate ration. Soybean pod is an agricultural waste obtained from soybean and have potency as alternative of beef cattle ration to replace the use of concentrate ration.

Conclusion: The use of complete feed containing 15 or 30% soybean pods, increased the feed intake of Madura cattle as compared to those given concentrate and control feeding treatments.

The use of concentrate ration and complete feed containing 15 or 30% soybean pods also increased feed efficiency, final body weight and average daily gain of the local cattle, compared to those given control feeding treatment.

Carcass and meat characteristics of Madura cattle fed soybean waste-based rations were similar to those fed 100% grass as control.

Soybean by-products can be potentially used as an alternative feed resources particularly in dry seasons.

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