Dietary energy utilization of indigenous sheep fed with complete feed consisting of agricultural and agroindustrial by-products[1]

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ABSTRACT: An experiment was carried out to investigate the utilisation of dietary energy of complete feed composed of various agricultural and agro-industrial by-products on indigenous male lambs. Sixteen indigenous sheep (13±1.46 kg of initial body weight, 3-5 m of age) were fed with various agricultural and agro-industrial by-products arranged in a completely randomised design with 4 different ration compositions (R1 = rice straw + soybean meal, R2 = maize straw + soybean sauce industry by product, R3 = peanut hay + coconut cake, and R4 = sugar cane + tofu cake) and 4 replications. Intakes of dry matter (DM), energy, digestible energy (DE), metabolizable energy (ME), and average daily gain (ADG) were measured and analyzed using ANOVA followed by Duncan's test.. The results showed that there were no significant differences (P>0,05) in all parameters measured. The daily intakes of DM, DE, ME and ADG were 923.59 g, 7.87 MJ, 6.89 MJ and 0.12 kg, respectively. The calculation on DE and ME requirement for 1 kg body weight gain were found to be 65.43 and 57.38 MJ, respectively. It was concluded that the dietary energy utilizations of complete feed consisting of agricultural and agro-industrial by-products on indigenous sheep were not different.

Key words: agricultural by-products, agro-industrial by-products, complete feed, sheep, dietary energy utilization

INTRODUCTION

Agriculture and agro-industry by-products are potential feed resources due to the low price, easily obtained, and still have a fairly good nutrition for livestock. These kinds of feedstuff are rice straw, maize straw, peanut hay, leucaena leaves, tofu cake, soybean sauce industry by-product, rice bran, coconut cake, soybean meal, and others. Some materials have different energy contents, digestibilities and utilizations, which greatly affect livestock production. Energy consumed by animal is not completely used by livestock, where some components of feed that can not be utilized will be released through feces, urine, methane, and heat. Energy retained in the body will be converted to body heat for basic living and stored for production (Ranjhan and Pathak, 1989). Energy utilization is influenced by the quality of feed consumed by animals, and therefore it might be worth to investigate the dietary energy from variety of agricultural and agro-industry by-products that can be utilized by sheep. The purpose of this experiment is to determine sheep dietary energy utilization of complete feed composed of various agricultural and agro-industries by-products.

MATERIALS AND METHODS

Sixteen male indigenous sheep with 13 ±1.46 kg of body weight were divided into 4 groups (4 per group) in a completely randomized design fed with different pelleted rations (R1, R2, R3, R4) using various agricultural and agro-industrial by-products. All rations contain 60% total digestible nutrients (TDN) and 15% crude protein (CP) as shown in Table 1. During experimental period, the sheep were kept in individual pens.

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Table 1. Composition and nutrient content of complete feed

Item	R1	R2	R3	R4
Feedstufs composition, % DM basis				
- Rice straw	25.00	-	-	-
- Maize straw	-	25.00	-	-
- Peanut hay	-	-	25.00	-
- Sugar cane	-	-	-	25.00
- Soybean meal	18.75	-	-	-
- Soybean sauce industry by product	-	8.50	-	-
- Coconut cake	-	-	7.50	-
- Tofu cake	-	-	-	16.00
- Leucanena leaf meal	4.00	25.00	19.00	23.50
- Dried cassava flour	12.25	10.00	9.00	3.00
- Rice bran	33.00	26.50	34.00	27.50
- Molasses	5.00	3.00	3.50	3.00
- Mineral	2.00	2.00	2.00	2.00
Nutritient content:				
- Dry matter, %	90.44	90.44	90.22	90.59
- Crude protein, %	16.99	14.97	14.93	13.60
- Energy, cal/g	3,570.45	3,792.41	3,736.61	3,852.34

The energy balance trials were measured by total collections in a 7-d total collection period following a 2-week feed adaptation period. Methane production was measured by the facemask method equipped with methane analyser (Horiba, Japan) for 10 min at 3-h intervals for 2 d immediately after the 7-d period ended (Terada et al., 1982). This hourly methane production was then converted into daily total production. Average daily gain (ADG) was measured after the sheep being raised for 12 wk. The data were analysed using F-test (Steel and Torrie, 1991).

RESULTS AND DISCUSSION

Average daily gain (ADG), dry matter intake (DMI), energy intake (gross energy, digestible energy, and metabolizable energy), and energy conversion were similar (P>0.05), as shown in Table 2. The DMI were similar among the treatments indicating that different types of feed materials composing in complete feed consumed did not significantly affect DMI. Parakkasi (1999) states that the factors affecting feed intake in ruminants are physical properties and chemical composition of feed. Differences in physical properties of feed can lead to different feed palatability (Soeharsono and Musofie, 2004). Complete feeds used in this study are in the form the pellet in the drafting process through a grinding process, so that the physical properties of different sets of feed material into the same, a result not significantly different from DMI. The advantages of pelleted feeds are able to consume the feed in accordance with the formulations that have been made, in contrast to the feed ingredients separately, then only consume feed ingredients are preferred. Average of DMI in this study was 923.59 g (5.31% of body weight). The DMI in this study has been arranged to fulfill the DMI requirements according to Ranjhan (1981), being 4.30 to 5.00% of body weight.

Gross Energy Intake

Gross energy intake (GEI) of all groups showed no significant differences (P> 0.05). This is a consequence of the non significant DMI differences among groups with similar feed energy contents. The average GEI was 14.46 MJ/d, which is higher than that obtained by Wijanarko (2005) who reported that indigenous sheep fed alcohol industrial sludge amounted to 11.37 MJ/d. This difference was due to the higher DMI in this study. GEI obtained by the study of Purbowati et al. (2008) using pelleted complete feed containing fish meal as one source of dietary protein was 12.66 MJ/d, considering lower DMI with feed energy content of 3738 cal/g.

Table 2. Energy utilization of local sheep fed complete feed consisting of agricultural and agro industrial by-products[1]

Item	R1	R2	R3	R4
ADG, kg/d	0.12	0.12	0.12	0.13
DMI, g/d	901.64	926.60	909.41	956.71
Energy intake,				
- GE, MJ/d	13.47	14.71	14.22	15.42
- DE, MJ/d	8.12	8.02	7.85	7.48
- ME, MJ/d	7.06	7.01	6.87	6.63
Energy loss through				
- Feses, MJ/d	5.36	6.69	6.37	7.94
- Urine, MJ/d	0.19	0.22	0.19	0.20
- Methane, MJ/d	0.86	0.79	0.79	0.65
Conversion of energy				
- GE, MJ/kg	110.76	128.30	118.22	119.99
- DE, MJ/kg	66.82	71.03	65.35	58.52
- ME, MJ/kg	58.12	62.28	57.19	51.93

[1]There were no significantly differences among treatments in all items (P> 0.05).

Digestible Energy Intake

Digestible energy (DE) intakes among groups were not significantly different (P> 0.05). Average DE intake was 7.87 MJ/d (54.43% of GEI). This percent of GEI were lower than that reported by Wibowo (2006) (55.75% of GEI, 5.72 MJ/d, considering as an effect of higher DMI in this study (923.59 g/d vs 634.2 g/d). Ranjhan and Pathak (1989) stated that DMI was one of the factors that influenced the digestibility. DM digestibility in this study (51.86%) was lower than that of Wibowo (2006) who found 56.04%. The lower DM digestibility was linear with the energy digestibility. Speedy (1985) stated that energy is supplied to animal from the feed consumed by animal. In addition, the energy loss through feces in this study was higher than that reported by Wibowo (2006) (6.96 MJ/d or 47.65% of GEI vs 4.54 MJ/d or 44.24% GEI). The percentage of energy loss through feces in this study was in the range of 45-50% of GEI as reported by Bondi (1987).

Metabolizable Energy Intake

The present study showed that metabolizable energy (ME) intakes were not significantly different among the groups (P> 0.05). This was because DE and energy loss through urine and methane among groups were not different. ME is the result after DE is subtracted from energy loss in the forms of urine and methane (Bondi, 1987). The average ME in this study was higher than the ME found by Wibowo (2006) (6.89 MJ/d or 48.13% of GEI vs 4.80 MJ/d or 46.78% of GEI.

Energy loss through urine were not significantly different among the groups (P> 0.05). Average energy loss through urine in this study (0.20 MJ/d, 1.38% of GEI) was lower than the results of Wibowo (2006) (0.70 MJ/d, 8.38% of GEI), but the energy loss in urine in this study was lower than of Wibowo (2006). However, both results are within the range of energy loss through urine (from 4 to 5% of GEI) as reported by Bondy (1987) and Edey (1983).

No significant differences were also observed on energy loss through methane (P> 0.05). Average energy loss trough methane was 0.77 MJ/d (5.38% of GEI). According to Tillman et al. (1991), one of the factors that affect energy loss through methane is the DMI, whereas DMI of all groups in this study were not significantly different (P> 0.05). Energy loss through methane of this study was lower than the research results obtained Wibowo (2006) (0.86 MJ/d or 8.39% of GEI). The protein content of feed in this study (15.12%) was higher than the protein content reported by Wibowo (2006) (13.22%). Shibata et al. (1993) stated that feeding with high protein content tended to decrease methane production. Energy loss through methane in this study were better than the range of energy loss through methane repoprte by Arora (1995) and Edey (1983), which was 8% of GEI. The smaller energy loss through methane would be better, considering that methane gas potentially damages the lining of the atmosphere by eroding the ozone layer by 20%. Therefore, the agricultural and agro-industrial by-products could be used to reduce methane emission in order to minimize adverse effects on nature.

Average Daily Gain

No significant differences in ADGs among the groups, was due to no significant differences in DMI, GEI, DE and ME. The ADG in this study was 0.12 kg/d. This result showed that the energy consumed by sheep may fulfill the requirement for maintenance and production. The rest of energy consumed by animal after being used for maintenance will be used for growth and production (Tillman et al., 1991). The results of previous study (Purbowati et al., 2008) obtained a higher ADG than of this study (0.15 kg/d). This is because the nutrients content of the feedstuffs used by Purbowati et al. (2008) contained CP ranging from 14.48 to 17.42%, while the CP content in this study was from 13.60 to 16.99%. The ADG of this study was higher than the results of Devi (2005) (0.06 kg/d). This difference was considered due to the different DMI. The DMI in this study (923.59 g/d) was higher than DMI in Devi (2005) (823.75 g/d). This confirmed the statement of Parakkasi (1999) that the ADG was influenced by feed intake and nutrient content.

Conversion of Energy

No significant differences in energy conversion (GE, DE, ME) into daily gain, gnificantly different (P> 0.05) that might be due the similarity of GEI (GE intake), DEI, MEI, and ADG of sheep in this study. The average values of GEI, DEI, and MEI conversions were 119.32, 62.31 and 57.38 MJ/kg, respectively, which were higher than those reported by Purbowati et al. (2008) who found 77.78, 45.11 and 38.91 MJ / kg of GEI, DEI, and MEI conversions, respectively. Higher or lower conversion values in this study compared to those of other studies was thought to be the influence of nutrients content in the diets. Purbowati et al. (2008) used the pelleted complete feed with 16.09% CP of resulted in 0.15 kg ADG/d, which was higher than the ADG obtained in this study (0.12 kg, 15.12% CP). Therefore, the nutrient utilization reported by Purbowati et al. (2008) was more efficient than that of this study.

CONCLUSIONS

Based on these results, it can be concluded that energy utilization of feed by sheep with complete feeds from various agricultural and agro-industries by-product, were similar. Those by-products are environmental friendly feedstuffs, as the utilization of those feedstuffs showed the potency to reduce methane emission. Further research should be directed to optimize those kinds of feedstuffs while exploring the new agricultural by products feedstuff.

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