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The Feed Intake and Daily Weight Gain of Locally Sheep Fed with Amofer Palm Oil Plantation and Mill's Byproduct-based Complete Feed

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Abstract *– Livestock development through innovation of complete feed (CF) technology which cheap and potential could be optimized through utilizing palm oil plantation and mill's by-product. The objective of this research was to analyze the effect of complete feed formulated with palm oil plantation and mill's by-product to the feed intake and daily weight gain of sheep. Male thin tailed sheep 9 months old with average live weight of 14.69 kg were used in this research. CF was formulated from ammoniated-fermented of palm frond, palm leave, empty fruit bunch, and palm pressed fiber which mixed with Centrosema sp., palm kernel cake, corn, rice bran, dried cassava waste pulp, molasses, mineral mix and salt. The study used completely randomized design which consisted of T_1=10%, T_2=12%, T_3=14% and T_4=16% of crude protein and total digestible nutrient (TDN) 64% with 4 repetitions. Data was analyzed using ANOVA at 95% significance level which followed by Duncan Multiple Range Test. The experiment showed that the level of protein content influenced the feed intake. The highest average of dry matter intake, organic matter intake, crude protein intake and TDN were 865.83 g/sheep/day, 750.60 g/sheep/day, 118.66 g/sheep/day and 555.96 g/sheep/day, respectively. The highest average daily weight gain was 174.18 g/sheep/day which produced at crude protein level of 14% (T_3). The statistical analysis showed that T_3 was significantly different to T_1, T_2 and T_4. It can be concluded that complete feed formulated from palm oil plantation and mill's by-product with appropriate level of crude protein content could increase the feed intake and daily weight gain of local sheep.*

Key words*—Feed, by-product, palm oil plantation and mill, feed intake, daily weight gain*

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I. INTRODUCTION

One of the important factors that need to be considered in sheep fattening is a guarantee of feed continuity. During fattening period, cattle must be fed continuously with sufficient quantity and quality. On the contrary, Indonesia has different availability in supplying the feed throughout the year (Purbowati *et al*., 2009; Hardianto *et al*., 1991). Good quality of feed and meets the standard enables cattle to run their metabolic process normally. Therefore, feed nutrient balance should raise an attention as it limits the productivity of ruminant in tropical area (Sunarso *et al*., 2007). Sheep fattening could give benefit but in general it still has low productivity. This condition is closely related to the availability of feed, brood and maintenance system, so the development is still wide opened (Pramono *et al*., 2009).

Feed availability which continuously provided throughout the year with quality and quantity which meets standard is an important factor that affects the productivity. Feed cost efficiency can be done by using low cost feedstuff, do not compete with human for food and available in abundant amount (Umiyasih *et al*., 2009). The amount of feed consumed is one element that is very important to support the basic needs of life, growth, production and reproduction of livestock (Sunarso, 2005). Ruminant feed consumption is influenced by the palatability of the feed which is determined by taste and smell, rumen capacity and dry matter content (Parakkasi, 1999; Soeharsono *et al*., 2011).

Feed with high nutritional value content and good palatability can rapidly increase the body weight gain of the livestock. Body weight gain is a result of an enlarged and increased of the body tissue as well as an improved ability to

convert the nutrient content contained in the feed into meat which influenced by the quality and quantity of the feed (Taylor, 1994; Parakkasi, 1999; Phillips, 2001; Harfiah, 2005; Salem and Smith, 2008).

Lately, the development of livestock business especially ruminant is felt difficult due to the decreasing area of forage planting and agricultural area. Therefore, it is necessary to find potential feedstuff resource including palm oil plantation. Palm oil sludge is one of palm oil byproducts which potential for feedstuff due to low price, abundant availability, good nutrient content, continue and not compete with human needs for food. Other sources are palm kernel cake and palm oil sludge. According to proximate analysis, it was noted that those byproducts are potential for feedstuff based on the dry matter content, crude protein content and total digestible nutrient (Mayulu *et al.*, 2013).

The utilization of those byproducts is very potential, but it still has low quality due to low content of crude protein (CP) and high content of crude fiber (CF) (Sutrisno, 2001; Sutrisno, 2002; Agricultural Research and Development, 2005; Harfiah, 2007). Palm oil frond and leaf could have an economic value if mixed together with additional feed which contains sufficient amount of protein and energy to meet standard nutrient value (Kuswandi, 2011). Fermentation process of palm kernel cake mixed with palm oil sludge could increase crude protein content up to 67% and reduced crude fiber content to 27% (Sutrisno, 2001; Hardianto, 2003; Umiyasih and Anggraeni, 2007; Puastuti, 2008). Amofer technology can increase the nutrient value of byproduct which indicated by the increasing value of crude protein content and decreasing value of crude fiber. This increasing was followed by the increasing of dry matter content, crude protein content and TDN so the feed resource is recommended as ruminant feed (Mayulu, 2014[a]).

In an effort to make efficient use of the feed, all nutrient component should be considered. Technology that has been developed by a research is feed processing technology from palm oil plantation and mill's byproduct. Innovation on complete feed technology can be carried out to obtain nutrient and energy balance to meet the basic needs of life and production of ruminant (Diwyanto, 2008; Kuswandi, 2011). The objective of this research was to evaluate the feed intake and daily body weight gain of thin tail sheep fed with complete feed which formulated from amofer (ammoniated-fermented) palm oil plantation and mill's byproduct.

II. MATERIAL AND METHOD

Material used in this research were as follows: 1) Complete feed which formulated from amofer palm oil's frond, amofer palm oil's leaves, amofer empty fruit bunch, amofer palm fresh fiber, amofer palm kernel cake, *Centrocema sp.*, corn, rice bran, dried cassava waste pulp, molasses, urea, mineral and salt Table 1; 2) 16 male of thin tail sheep with aged of $\pm$9 months old and average body live weight 14.69$\pm$0.82 kg (CV=5.57%); 3) Individual cage with 150 cm x 75 cm size, weight scale of *Electronic Kitchen Scale* Model EK3651 with 5.000 gram capacity, and sheep weight scale of *Portable Electronic Scale* Model DFS 011008 with 40 kg capacity.

Completely randomized design with four treatments and four replications at each treatment were used in this research. The treatment was complete feed ratio which consisted of T_1=10.63% CP; 63.46% TDN; T_2=12.27% CP; 62.38% TDN; T_3=13.70% CP; 64.11% TDN; and T_4=15.90% CP; 61.28 TDN.

Ammoniation on palm frond, palm leave, empty fruit bunch and palm pressed fiber was carried out by adding urea at 3% of the total material (Musalia*et al.*, 2000) and fermented under aerobic condition inside the black plastic with capacity of 25–30 kg for 18 days, and then fermented using microbe starter at 1% of the total material and then fermented again for 18 days. The ammoniated-fermented result was then air dried and milled using grinder with 0.7 mm size grinder and mixed with palm oil sludge, palm kernel cake, *Centrosema sp.*, corn, rice husk, dried cassava waste pulp, molasses, urea, mineral and salt using mixer. The next step was milling process using 0.5 sieve grinder and 0.3 mm at the finishing stage to obtain complete feed in mash form. This whole process was carried out in Laboratory of Animal Feed and Nutrition, Faculty of Animal and Agricultural Sciences, Diponegoro University.

Table 1. Feedstuff Composition and Nutrient Content of a Complete Feed (based on Dry Matter)

Composition	Treatment			
	T_1	T_2	T_3	T_4
Feed Material Contained in CF	.....(%).....			
Palm frond	5.00	9.50	11.60	5.00
Palm leaves	1.00	2.10	3.00	13.40
Empty fruit bunch	4.00	5.00	4.00	3.00
Palm pressed fiber	17.00	6.00	4.00	3.00
Palm oil sludge	1.00	4.00	6.00	5.00
Palm kernel cake	10.50	10.00	10.00	4.50
Centrosema sp.	0.50	2.00	0.50	5.50
Corn	14.00	7.00	9.00	16.00
Rice bran	5.00	19.10	29.00	26.00
Dried cassava waste pulp	40.00	33.00	20.40	16.00
Molasses	0.50	0.50	0.50	0.50
Urea	-	0.30	0.50	0.60
Mineral	1.00	1.00	1.00	1.00
Salt	0.50	0.50	0.50	0.50
	100.00	100.00	100.00	100.00
Nutrien content of CF				
Dry matter[1]	84.34	84.49	83.21	82.00
Organic matter[1]	90.09	88.31	86.69	87.31
Crude protein[1]	10.63	12,27	13.70	15.90
Crude fat[1]	2.00	2.09	2.40	2.18
Crude fiber[1]	22.58	24.09	22.53	25.22
NFE	54.88	49.86	48.05	44.01
TDN[2]	63.46	62.38	64.11	61.28
Ca[3]	0.43	0.34	0.31	0.30
P[3]	0.30	0.24	0.27	0.21

[1]Proximate analysis result conducted in Animal Feed and Nutrition Laboratory, Faculty of Animal and Agricultural Sciences, Diponegoro University; [2]Calculation result (Sutardi, 2001); [3]Analysis result conducted in Nutrient Biochemical Laboratory, Faculty of Animal and Agricultural Sciences, Diponegoro University

Intervention activity was carried out at Laboratory of Animal Feed and Nutrition, Faculty of Animal and Agricultural Sciences, Diponegoro University, Semarang. The first intervention activity was weighing the initial weight of the sheep. The sheep was randomized into four treatment groups and placed into individual cage. The sheep was orally treated with worm control Vermiprazol 10% at doses of 2.5 ml. Prior the test, the sheep was placed into the cage and fed with complete feed for 7 days to eliminate the effect of previous feed so the condition of the sheep was stable.

Complete feed was given to the 16 male of thin tail sheep which divided into four groups with four replications.

Complete feed diet was offered daily from 07.00 up to 20.00 for 98 days. Weighing and recording of complete feed offered were carried out routinely. The complete feed that was offered at the experiment day and the remaining complete feed offered the day before (at 06.00–07.00) were weighted and recorded routinely. Ten days before the final experiment, the remaining feed was collected and taken around 5% for dry matter analysis. Drinking water was given ad libitum. Dry matter intake was calculated from multiplication of total CF offered with % of dry matter of complete feed and then deducted with the multiplication of discharged complete feed with discharged % of dry matter of complete feed. OM intake was obtained from multiplication of dry matter of the complete feed intake (g) with % of organic matter intake. Crude protein intake was obtained from multiplication of dry matter of the complete feed intake (g) with crude protein of the complete feed. TDN intake was obtained from multiplication of dry matter of the complete feed intake (g) with % TDN. Body live weight was measured every two weeks prior the completion of the research which conducted prior the feeding. Daily weight gain was obtained from the different between final weights with initial weight which divided with total days of research (gram/sheep/day) (Tulloh, 1978; Parakkasi, 1999).

III. RESULT AND DISCUSSION

Feed Intake

The feed intake of sheep after treated with complete feed is shown in Table 2. The highest average intake of dry matter, organic matter and TDN was T_3 followed by T_1, T_2 and T_4. The highest average intake of crude protein was T_3 and followed by T_4, T_2 and T_1. The variance analysis showed that the feed intake among four treatments was significantly different ($p<0.05$). The result of Duncan test showed that T_3 was more significantly different upon different crude protein levels (10, 12, 14 and 16%) at relative similar energy level (TDN) compared to T_2 and T_4 but not significantly different to T_1. The average intake of organic matter showed that T_3 was significantly different to T_4 but not significantly different to T_1 and T_2. The average intake of crude protein showed that T_3 was significantly different to T_2 and T_4 but not significantly different to T_1.

Table 2. The average nutrient intake of the sheep

Variable	Treatment			
	T_1	T_2	T_3	T_4
	.....(g/ekor/hari).....			
DMI	817.7±49.9^{ab}	746.3±16.9^{b}	865.8±35.2^{a}	606.9±123.0^{c}
OMI	736.7±44.9^{a}	659.0±14.9^{a}	750.6±30.5^{a}	529.9±107.4^{b}
CPI	86.9±5.3^{b}	91.6±2.1^{b}	118.7±4.82^{a}	96.5±19.6^{b}
TDN intake	520.5±31.8^{ab}	461.4±10.4^{b}	556.0±22.6^{a}	365.7 ±82.8^{c}

Superscript with different letter at the same row shows significant different ($p<0.05$); Remarks: DMI=Dry Matter Intake; OMI=Organic Matter Intake; CPI=Crude Protein Intake

The research found that the formulation of complete feed did not impact the flavor and appetite of the sheep. Different organic matter intake and dry matter intake which followed by different crude protein level indicated different crude protein intake. Even the TDN of the complete feed was relatively similar but the dry matter intake and organic matter intake was different which caused the differences in TDN intake. The increasing of feed intake would increase the weight gain. Based on the crude protein level treatment, dry matter intake could be estimated by cubic equation as follow: $y=23{,}968.143–5{,}638.01X+450.92X^2–11.86X^3$ ($R^2=72.65\%$). According to the equation, it can be calculated that the maximum dry matter intake occurred at 14% of crude protein level (Figure 1).

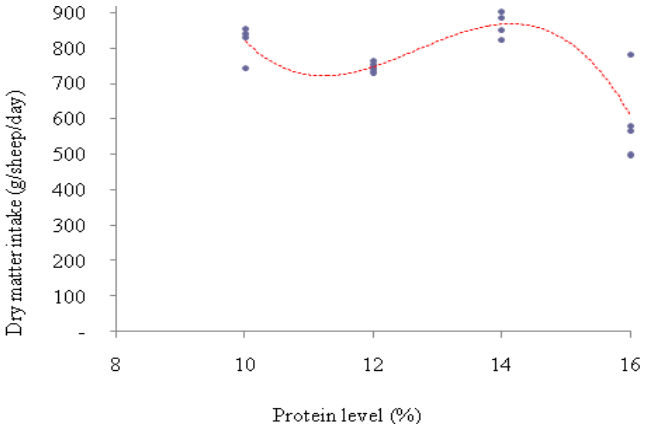

Figure 1. Dry Matter Intake under Different Protein Content

The dry matter intake resulted in this research was higher than the dry matter intake resulted from Bulu *et al.* (2004) which used dried tofu waste 1.8% of the total weight 19.99 kg of thin tail sheep i.e. 422.63 (g/sheep/day). Nirwana (2005) observed male local sheep 12 kg fed with corn forage and concentrate containing fermented-dried cacao pulp resulted 465.83 (g/sheep/day) of dry matter intake. Arifin *et al.* (2010) resulted 274.82 g/day of dry matter intake on sheep with body live weight 13.2–18.5 kg.

This result corresponds to Rachmawan (2008) who found that Priangan sheep 19.40 kg fed with King grass and concentrate containing fermented-rubber seed cake resulted dry matter intake 809.57–818.20 g/sheep/day. Daulay *et al.* (2008) found that male sheep 16.87 kg fed with field grass 100% added with mal nutrition block and supplemented with 4% of ultra-mineral resulted dry matter intake 821.64 g/sheep/day. Sugiyono (2010) found that 20 kg of male thin tail sheep fed with cut king grass and 450 g of dried tofu waste resulted in dry matter intake of 853.29 g/sheep/day. Furthermore, Akhadiarto (2009) found that 20 kg of male local sheep fed with paddy straw and dried cassava waste ration supplemented with fresh cow's rumen liquid resulted in dry matter intake of 856.6 g/sheep/day.

However, the result of this research was still lower than dry matter intake resulted from Purbowati *et al.* (2008) who found that the dry matter intake of 12.76 kg male local sheep fed with complete feed (crude protein content was 17.35%) and offered for 6% of the total body weight was 942.72 g/sheep/day. In addition, Purbowati *et al.* (2009) also found that the dry matter intake of 13±1.46 kg male local sheep fed with complete feed in the form of pellet which formulated from agricultural and agro-industrial waste was 924 g/sheep/day.

Feed intake capability describes the palatability of the feed. The highest dry matter intake resulted from this research was obtained from complete feed which formulated with 14% of crude protein content (865.83 g/sheep/day). This finding was

not much different to Kearl (1982) and NRC (2007) who stated that 30 kg of male local sheep need dry matter intake as much as 830 and 840 g/sheep/day, respectively. Palatability is influenced by physical properties i.e. firmness, color, texture, and shape such as mash, pellet, crumble. It is also influenced by chemical properties i.e. water content, protein and other substances. The sight and smell senses of sheep have important role but color doesn't influence the senses. Palatability can be quantitativelymeasured bythe number offeed intake(g /kg) in unitsof time (Parakkasi, 1999; NRC, 2000; Soeharsono *et al.*, 2011). The fundamental reasonof complete feed'sdry matter intakewas higherbecause it hada smooth textureanda highlevel ofpalatability. These results arealsoin linewithAnggorodi(1994), andTilman*etal.* (1998) who stated that feed intake is influencedby thepalatabilityandnutritionalvalue of the rations.

The value of organic matter intake could be estimated based on the crude protein level contained in the complete feed using this cubic equation: $y=20{,}513.134–4{,}796.88X + 382.222X^2–10.03X^3$ (R^2=73.55%). Thus, it can be equated that the maximum organic matter intake occurred at 14.10% of crude protein level (Figure 2).

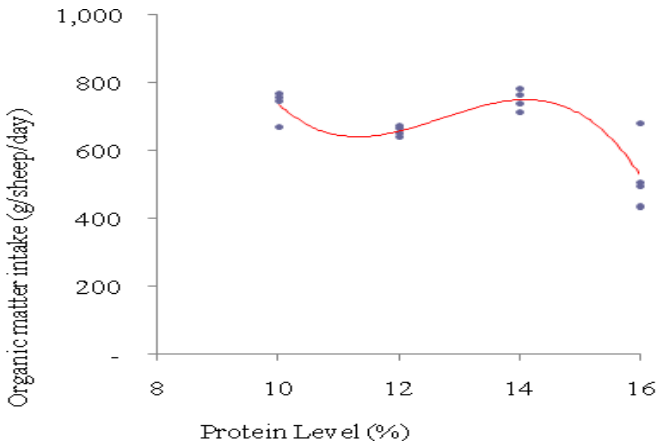

Figure 2. Organic Matter Intake under Different Protein Content

The difference of organic matter intake on T_3 and T_4 was closely related to higher dry matter intake contained in T_3. On the contrary, there were no differences among T_3, T_1 and T_2. Principally, the proportion of organic matter contained in dry matter content is the highest which indicates that the organic matter intake is in line with the dry matter intake. It is expected that higher organic matter intake will result in higher energy and can be utilized to carry out metabolic process.

The crude protein intake could be estimated based on crude protein level contained in CF using this following cubic equation: $y=2{,}908.673–698.429X + 56.556X^2–1.493X^3$ (R^2 = 64.30%). According to the equation, it could be calculated that the maximum crude protein intake occurred when the level of crude protein was 14.50% (Figure 3). The crude protein intake resulted by Purbowati *et al.* (2009) using complete feed containing crude protein level 13.60–16.99% ranged between 130.08–153.18 g/day. On the contrary, Purbowati *et al.* (2007) used complete feed containing crude protein content 14.48–17.42% resulted in dry matter intake of 112.33–165,80 g/day. If compared to crude protein needed by breeding sheep which was 93.80–142.90 g (Ranjhan, 1981), the result of Purbowati *et al.* (2009) has fulfilled the needs of the sheep.

The difference of crude protein intake is due to differences on the dry matter intake and organic matter intake. The increasing of crude protein causes the increasing of dry matter intake, organic matter intake, crude protein intake and TDN to a certain limit and then decreases at crude protein content 16%. Different protein content contained in complete feed should provide differences following the protein content in complete feed, but fact showed that T_4 was not better than T_3. This could be due to the crude fiber content and TDN of T_3 was much better than T_4.

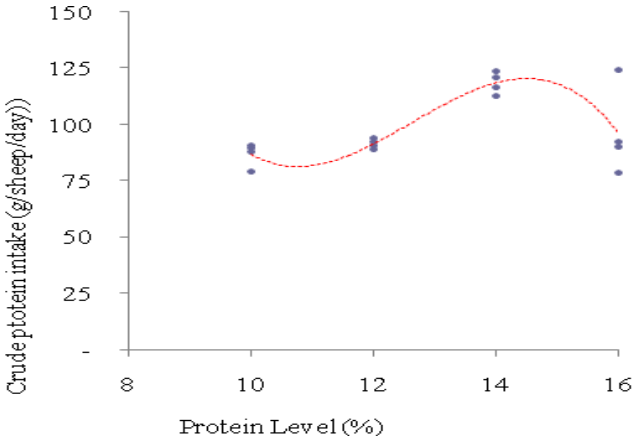

Figure 3. Crude Protein Intake at Different Protein Content

The TDN intake could be estimated based on crude protein level contained in CF using this following cubic equation: $y =18{,}463.082–4{,}360.880X+347.995X^2–9.133X^3$ (R^2=76.55%). According to the equation, it could be calculated that the maximum crude protein intake occurred when the level of crude protein was 14.17% (Figure 4). The TDN intake among treatments was not significantly different which could be due to the TDN content that was relatively similar and dry matter intake which not significantly different. According to Rodotis and Bell in Parakkasi (1999), the needs of feed energy is determined by environment, age, body weight, race, feed composition and desired body weight gain. Haryanto and Djayanegara (1993) stated that the environmental condition that affects the needs of energy is temperature, relative humidity and wind speed. TDN intake was not significantly different could be due to feed factors, feed composition, cattle and similar environment. The average TDN intake resulted by Purbowati *et al.* (2009) was 469.37 g. Thus result was higher than Rianto *et al.* (2006) which found that the average TDN intake was 341.33 g but lower than the result found by Purbowati *et al.* (2005) i.e. 724.02 g. The average TDN intake found by Purbowati *et al.* (2009) has met the standard determined by Ranjhan (1981) i.e. 410-680 g.

Complete feed in mash form was proved palatable for sheep. The flavor was sweet as the addition of molasses. Different effect occurred due to the different of crude fiber content at each treatment. This research found that T_3 had lower crude fiber content and higher TDN. Based on the result of proximate analysis, it was found that crude fiber

content in complete feed was T_1=22.58%; T_2=24.09%; T_3=22.53%; and T_4=25.19%.

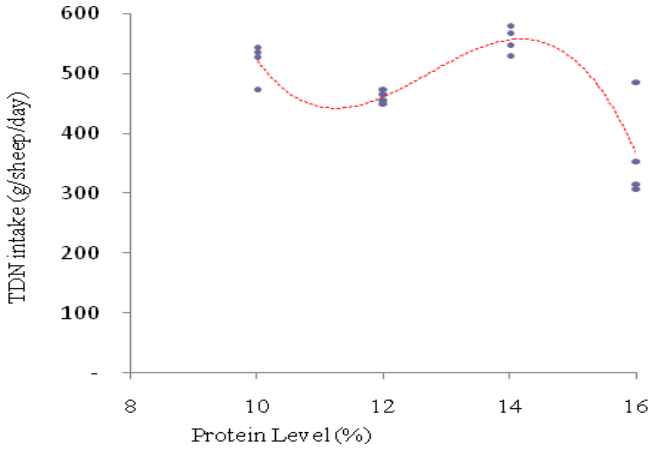

Figure 4. TDN Intake at Different Protein Content

A processing of palm oil waste as feedstuff is in line with the previous research. Silage and ammoniated-palm leaves treatment as raw material for sheep could increase the content of dry matter, organic matter, NH_3, pH and increased the feed digestibility and intake. It also gave positive impact to energy and nitrogen balance. Solid palm oil waste in block complete feed is potential for cattle's nutrition source as it contains 12.63% of crude protein and 154 kal.100/gram of energy which could significantly increase the daily body weight gain and safe for cattle (Hanafi, 2004; Utomo, 2004). Palm kernel cake had higher nutrient content compared to others byproducts which could be used for concentrate (Sabu *et al.*, 2005). It consists of 90% of dry matter, 16.1% of crude protein, 15.2% of crude fiber, 4% of ash, 63% of extract matter without N, 0.29% of calcium, 0.71% of phosphor, and 6.2% of metabolized energy. Palm oil sludge could increase the daily body weight gain of cow and sheep as much as 0.77 g/cow/day and 0.03 g/sheep/day (Widjaja and Utomo, 2005). Previous research related with the uses of complete feed formulated from ammoniated and fermented-feed stuff showed that the complete feed is safe for sheep as it is not toxic, not cause haematological and lever malignancies as indicated by the blood profile (hemoglobin, hematocritandglucose level) and *alanine aminotransferase* (ALT) level and *aspartate aminotransferase* (AST) is in normal range (Mayulu *et al*., 2012).

Daily Weight Gain

The highest daily weight gain occurred at T_3 treatment and followed by T_1, T_2 and T_4 (Table 3). The analysis of variance showed that daily weight gain resulted from four treatment was significantly different ($p<0.05$). The result of Duncan demonstrated that T_3 was significantly different to T_2 and T_4 but not significantly different to T_1. The analysis showed that complete feed which formulated from palm oil plantation and mill's byproduct with appropriate crude protein could increase the daily weight gain of the sheep.

Table 3. Average Daily Body Weight Gain of the Sheep

Variable	Treatment			
	T_1	T_2	T_3	T_4
Daily body weight gain (g/sheep/day)	161.0±6.4^{ab}	143.2±16.6^{b}	174.2±4.0^{a}	113.0±4.8^{c}

Different superscript at the same row shows significant different ($p<0,05$).

The daily body weight gain resulted from this research was 112.98–174.18 g/sheep/day (Figure 5). This value was higher than daily weight gain of male local sheep 10–14 kg fed with palm pressed fiber which ammoniated using urea and supplemented with cassava leaves. The daily body weight gain resulted from this research is 54 g/sheep/day (Zain, 2007). Rachmawan (2008) used 22% of fermented rubber seed cake for Priangan sheep with 9 months age and 19.40 kg body weight. This treatment resulted daily weight gain of the sheep by 64.89 g/sheep/day. Utomo and Widjaja (2004) found that fresh solid with 1% of the total body weight, unfermented complete feed block and fermented complete feed block resulted daily weight gain by 45, 64, and 83 g/sheep/day.

Corn and concentrate with 20% of fermented cacao peel powder resulted daily body weight gain by 83.33 g/sheep/day (Nirwana, 2005). Sugiyono (2010) showed that King grass forage mixed with dried tofu waste resulted daily weight gain of 20 kg thin tail sheep by 96.25 g/sheep/day. All these results demonstrate that this research give higher daily body weight gain among others.

The daily weight gain resulted from this research confirm the result of Purbowati (2008) who found that complete feed with 17.35% of crude protein content resulted daily body weight gain by 164.98 g/sheep/day on male local sheep. Moreover, Purbowati *et al.* (2009) resulted the daily body weight gain by 150-165 g/day on sheep fattening fed with complete feed in form of pellet. Akhadiarto (2009) also resulted daily body weight gain by 173.5 g/sheep/day on 20 kg of male local sheep fed with paddy straw and dried cassava waste pulp.

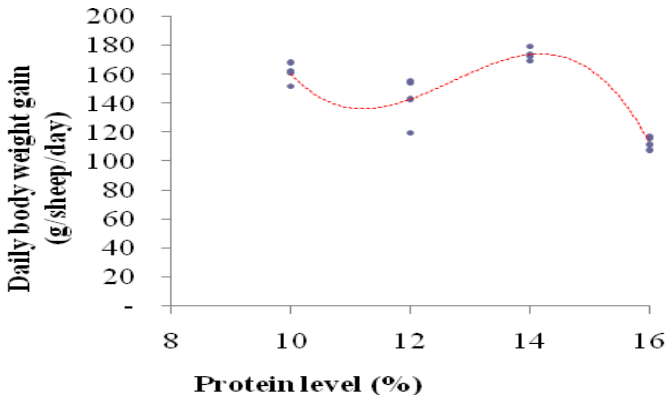

Figure 5. Graph of Daily Body Weight Gain at Different Protein Content

Body weight gain is the result of nutrient consumed and became one of influential factors as related to the nutrients contained in the feed and the digestibility of the feed (Taylor,

1994; Parakkasi, 1999; Phillips, 2001; Harfiah, 2005; Salem and Smith, 2008). The increasing of daily body weight gain is presumably due to the increasing of dry matter and crude protein intake, the digestibility and metabolic of protein. These factors could increase the protein amount which can be utilized to form body tissue. High magnitude of daily body weight gain on sheep indicates that complete feed has good quality and palatability. High ration intake and digestibility causes high protein intake and N retention which leads to the increasing of daily body weight gain.

However, a situation occurred where higher protein (16%) in T_4 resulted lower daily body weight gain than T_3. This could be due to dry matter intake on T_4 was lower which resulted lower crude protein intake and lower TDN. In term of crude protein intake and TDN ratio, T_3 was lower (0.21) than T_4 (0.27). This indicates that complete feed resulted from T_4 treatment experienced excess protein ration that can't be utilized for daily body weight gain.

IV. CONLUSIONS

It can be concluded that complete feed which formulated from palm oil plantation and mill's byproduct with appropriate crude protein content could result better feed intake and daily weight gain on local sheep

SUGGESTION

It should be done for advances research which use the Complete Feed based by-product of oil palm plantation and mills modificated, such as pellets, crumble and wafer to sheep and other ruminants.

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