



International Journal of Science and Engineering (IJSE)

Home page: <http://ejournal.undip.ac.id/index.php/ijse>



*The Effects of Dietary Neutral Detergent Fiber Ratio from Forage and Concentrate on The Dietary Rumen Degradability and Growth Performance of Philippine Native Goats (*Capra hircus* Linn.)*

Dwiatmoko Nugroho¹⁾, Sunarso¹⁾, Cesar C. Sevilla²⁾, and Amado A. Angeles²⁾

¹⁾ Master program in Animal Science, Faculty of Animal Science and Agriculture, Diponegoro University, Semarang 50275

²⁾ Animal Science and Dairy Cluster, University of the Philippines Los Baños

Email: abecede_koko@yahoo.com

Abstract — This research's objective was to determine the dietary rumen degradability and growth performances of goats fed dietary treatments. 18 native female goats (live weight of 7.96 ± 2.21 kg) were grouped into 6 classes for the feeding trial and 3 male mature goats with rumen cannula were used for the in situ digestibility. The three dietary treatments were: T1 - 72:28 Forage-Concentrate NDF ratio; T2 - 64:36; and T3 - 57:43. The rate of rumen degradability of DM and CP at 0 hours, potentially degradable fraction (b) and the rate of degradation of b were not affected by dietary treatments. The different ratios of NDF in the diets significantly affected the intake of DM, CP and NDF from forage and concentrates. Treatment diets affected the total intake of DM, CP and NDF of the animals. However, growth performance was not affected by the treatments showing the same production efficiency. This means that diets given to native goats with ratio of forage NDF of 72.07% can be applied since the value of the output and efficiency of feed utilization had the same value compared to diets ratio of forage NDF of 57.21%.

Keywords — Feed utilization; Forage NDF; Goat; and Ration

Submission: 10 January 2014

Corrected: 11 January 2014

Accepted: 15 January 2014

Doi: [10.12777/ijse.6.1.75-80](https://doi.org/10.12777/ijse.6.1.75-80)

[How to cite this article: Nugroho, D., Sunarso, S., Sevilla, C.S., and Angeles, A.A. (2014). The Effects of Dietary Neutral Detergent Fiber Ratio from Forage and Concentrate on The Dietary Rumen Degradability and Growth Performance of Philippine Native Goats (*Capra hircus* Linn.), International Journal of Science and Engineering, 6(1),75-80. Doi: [10.12777/ijse.6.1.75-80](https://doi.org/10.12777/ijse.6.1.75-80)

I. INTRODUCTION

Farmers use high proportion of concentrates in the ration to accelerate the growth and production of ruminants. Although it has a positive impact on productivity, the use of excessive concentrate will lead to an increased production cost. Approximately 60% of the cost of production can be attributed to the concentrates fed to the animals (Chantaprasarn and Wanapat, 2008).

Nutrients are needed for the maintenance and production of animals. Aside from crude protein (CP), energy and minerals, the content of neutral detergent fiber (NDF) in the feed ration should also be considered. The sources for NDF are concentrates and forage. The proportion of forage NDF in the ration also plays a role in ruminant productivity. It is associated with chewing activity, saliva production, fermentation rate and yield, and digestibility of feed. Chewing time is highly influenced by NDF content, rather than with the particle size (PS) of forage (Beachemin, 1991 cited by Moon *et al.*, 2004). Feed rations with sufficient NDF content from roughages or forage can be given to dairy

animals to maximize production and maintain health by sustaining a stable environment in the rumen (Tafaj *et al.*, 2005).

The level and ratio of NDF in the diet can be used as standard to formulate proportion of forage and concentrate in the diets. With the optimized value of NDF, it can improve the performance of ruminant. In general, optimizing forage as source of NDF will indirectly decrease production costs while increasing revenue without reducing the quality and quantity of production. Theoretically, the value of NDF from forage is more useful by around 50% than concentrates (NRC, 2001). The ratio of forage and concentrate of the diet should contain around 75% forage NDF but in temperate regions, the minimum NDF level is around 25% to 28%. Because of the poor quality of forage in the tropics, this recommended NDF level is relatively difficult to maintain. A minimum of dietary NDF level (25%) and proportion of forage NDF (75% to 60%) in the diet still provides sufficient utilization of fiber for production and maintains fat corrected milk (Kanjaprapruthipong *et al.*, 2001).

Level of ruminant productivity is sensitive to dietary NDF level. High producing ruminants require NDF level of approximately 32% while animal with low productivity will require 44% of the ration (NRC, 2001). It is important to observe and evaluate the impacts of forage NDF in the diets as recommended by NRC, with some adjustments based on the tropical condition and practical conditions in the farm. The main objective of this research is to determine the ratio of NDF from forage and concentrate for optimum dietary rumen degradability and growth performances of Philippine native goats.

II. MATERIAL AND METHOD

Experimental Animals

Eighteen (18) native female goats were grouped into 6 weight classes for the feeding trial following a randomized complete block design (RCBD). The average body weight (BW) of the animals was around 7.96 ± 2.21 kg (CV = 27.76%) and were approximately 1 year of age. For *in situ* digestibility, three (3) male of mature goats were composed following latin square design (LSD), that were surgically fitted with cannulated rumen.

Experimental and Treatments Design

The dietary treatments were composed of *P. purpureum* as source of forage, commercial concentrate mixture, urea and molasses. The nutrient composition of *P. purpureum* and a commercial concentrate mixture used in the experiment is shown in Table 1.

Table 1. Nutrient content of feed ingredients (%)

Ingredients*	CP	EE	CF	ASH	NFE	NDF
<i>P. purpureum</i> ¹	12.88	1.44	29.32	18.40	35.64	63.87
Concentrate ¹	17.62	7.33	12.28	8.10	54.67	58.06
Urea ²	281.00	0.00	0.00	0.00	0.00	0.00
Molasses ³	3.94	0.30	0.40	11.00	84.36	0.00

Note: *Based on DM basis; ¹ Reported result from Animal Nutrition Laboratory; Animal and Dairy Science Cluster, UPLB; ² NRC (1988); ³ NRC (2001); CP is crude protein; EE is extract ether; CF is crude fiber; NFE is nitrogen free extract; NDF is neutral detergent fiber.

Three dietary treatments were used for all studies as follows:

T1 - 72 : 28 NDF Forage-Concentrate Ratio

T2 - 64 : 36 NDF Forage-Concentrate Ratio

T3 - 57 : 43 NDF Forage-Concentrate Ratio

Table 2. The proportion or level of forage and concentrates NDF in each treatment

	T1	T2	T3
Total NDF (g)	133.92	131.77	133.90
Forage NDF (g)	96.64	84.27	57.21
Cons. Mix NDF (g)	37.28	47.50	56.94
Forage NDF (%)	72.07	63.87	57.21
Cons. Mix NDF (%)	27.93	36.13	42.79
Forage portion (%)	67.89	60.48	53.41
Concentrate portion (%)	32.11	39.52	46.59

Note: T1 is 72 : 28 NDF Forage-Concentrate Ratio; T2 is 64 : 36 NDF Forage-Concentrate Ratio; T3 is 57 : 43 NDF Forage-Concentrate Ratio.

The ratios of NDF from forage and concentrate were calculated based on the total amount of NDF supplied by forage and concentrate portions. The proportion of NDF from forage and concentrate in the diets are shown in Table 2. The different dietary NDF ratios were attained by adjusting the forage to concentrate ratio based on the formulation in Table 3.

Table 3. Composition of feed ingredients in the dietary treatments (%)

Compositions	T1	T2	T3
<i>P. purpureum</i>	67.41	60.71	54.00
Concentrate	27.09	35.24	43.40
Urea	0.50	0.30	0.10
Molasses	5.00	3.75	2.50
Total	100.00	100.00	100.00

Note: T1 is 72 : 28 NDF Forage-Concentrate Ratio; T2 is 64 : 36 NDF Forage-Concentrate Ratio; T3 is 57 : 43 NDF Forage-Concentrate Ratio.

The dietary nutrient content of the treatments are shown in Table 4. The dietary crude protein ($13.71 \pm 0.14\%$) and total digestible nutrients (TDN) ($66.61 \pm 4.81\%$) used in studies 1 and 2 were formulated to be equal between the treatments. The diets were adjusted to be isocaloric and isonitrogenous by using urea and molasses. TDN content of *P. purpureum* (NP), mixed concentrates 1, 2, and 3 were estimated using the formulation used by Sutardi (2001) and converted based on the total amount of TDN on digestibility study.

Table 4. Nutrient contents of treatment diets (%)

Nutrient contents	NP	C1	C2	C3	D1	D2	D3
DM	100	100	100	100	100	100	100
CP	12.88	19.00	19.00	16.52	13.54	13.81	13.77
TDN	56.64 ¹	81.16 ¹	80.11 ¹	77.48 ¹	65.93	65.55	68.37
NDF	63.87	52.31	55.29	55.21	58.94	60.14	60.65
EE	1.44	4.88	5.51	1.51	2.19	2.73	3.28
CF	29.32	8.63	9.58	9.75	19.98	20.39	19.17
ASH	18.40	7.66	7.56	7.28	14.15	13.62	13.14
NFE	35.64	56.40	54.11	61.71	48.19	47.78	48.93

Notes: NP : Napier grass or *Pennisetum purpureum*; C1: Concentrate was mixed with urea and molasses based on treatment 1; C2: Concentrate was mixed with urea and molasses based on treatment 2; C3: Concentrate was mixed with urea and molasses based on treatment 3; D1: Napier was mixed with mixed concentrate based on treatment 1; D2: Napier was mixed with mixed concentrate based on treatment 2; D3: Napier was mixed with mixed concentrate based on treatment 3; ¹: TDN value based on the equation from Sutardi (2001).

Research procedures feeding trial: The adaptation period of the animals to the environment and ration consisted of 7 days. On the second day, the goats were placed in their respective cages based on the weight of group (6 groups) as a blocking factor then the goats within each group were randomly assigned to 3 treatments. At this stage, the ability of goat for consuming feed was observed. At the end of the preliminary stage, goats were first weighed to obtain initial body weight and were weighed weekly during the experiment. Treatment diets were given at 3% of body weight. The goats were fed three times a day: morning (8:00 and 11:00 am) and afternoon (3:00 pm). Concentrates were fed first, followed by feeding of forages one hour after. Drinking water was provided ad libitum. Nutrient contents of dietary treatments

were analyzed for proximate and NDF analysis following standard methods (AOAC, 1984, Van Soest *et al.*, 1991).

Research procedures *in situ* study: Approximately 2 g of the diet was weighed in duplicate into nylon bags as described by Ørskov *et al.* (1980); Isah and Babyemi (2010). The bags were 5x13 cm in size, with a pore size of 41 µm. The bags were inserted via permanent ruminal cannulae in 3 male goats and left in the rumen for 3, 6, 12, 24, 36, or 48 hours. At the end of the incubation period, all bags were withdrawn at the same time (Osuji *et al.*, 1993; Isah and Babyemi, 2010). The animals were fed with Napier grass (*Pennisetum purpureum*) at 7:00 am, 11:00 am, and 3:00 pm for *ad libitum*. The animals are also supplied with *ad libitum* fresh and clean water.

After finishing incubation, bags were washed under running cold water until the rinse water got clear and then dried in an oven for 48 hours at 105°C. Determination of washing loss at zero time (incubation at 0 hour) was carried out by soaking two of the bags containing each of the samples in tap water for 1 hour. The dry bags were weighed and DM loss was calculated.

Disappearance was calculated using the formulation stated by Osuji *et al* (1993),

$$\text{Disappearance} = \frac{(\text{SWa}-\text{BW}) \times \text{DMa} - (\text{SWb}-\text{BW}) \times \text{DMb}}{(\text{SWa}-\text{BW}) \times \text{DMa}} \dots\dots\dots(1)$$

Where:

SWa = Weight of the original sample + nylon bag

BW = Weight of empty nylon bag

SWb = Weight of the sample +nylon bag after incubation

DMa= Dry matter of feed sample

DMb= Dry matter of residue sample

Where the model of DM disappearance (McDonald (1981) cited by Osuji *et al* (1993)) is fitted to summarise the data and derive degradation parameter.

$$Y = a + b (1 - e^{-ct}) \dots\dots\dots(2)$$

Where:

Y = degradability at time (t), consisted of dry matter (DM) degradability, NDF and CP degradability

a = intercept

b = potentially degradable fraction

c = rate of degradation of b

Data analysis

The data were analyzed using ANOVA. Treatment mean differences were tested using Tukey's method with error level (α) of 5% (Gaspersz, 1991). The MINITAB 14 was used for running the analysis of variance and Tukey's test for other analyses, if necessary.

III. RESULT AND DISCUSSION

In Situ Degradability

Dry matter degradability at 0 hour, or degradability caused by the washed nylon bag is shown in Table 5. Treatments 1, 2, and 3 did not significantly affect the rate of degradability of dry matter at 0 hours ($p>0.05$). The average dry matter degradability at 0 hours, at T1, T2 and T3 were 30.98, 29.01 and 29.38%, respectively.

Levels of b or potentially degradable fraction of dry matter degradability on each treatment showed no significant difference ($p>0.05$). This indicates that the potentially degradable fraction of each treatment was relatively the same. The mean of potentially degradable fraction in Treatments 1, 2, and 3, were 36.63, 53.56 and 44.08%, respectively.

Table 5. Rumen degradability, feed, nutrients intake and performance of the native goats fed with the experimental diets.

PARAMETERS	T1	T2	T3
<i>Dry Matter Rumen Degradability</i>			
a or intercept (%)	30.98±2.33	29.01±5.41	29.38±4.59
b or potentially degradable fraction (%)	36.63±2.72	53.56±15.16	44.08±8.49
c or rate of degradation of b	0.05±0.01	0.03±0.02	0.05±0.02
<i>Crude Protein (CP) Degradability</i>			
a or intercept (%)	43.33±4.25	44.44±11.37	46.50±7.75
b or potentially degradable fraction (%)	34.16±3.72	32.39±8.69	43.30±3.68
c or rate of degradation of b	0.04±0.00	0.03±0.00	0.03±0.00
<i>Dry Matter Intake, g/d</i>			
Forage	151.31±46.4 0 ^a	131.94±36.5 0 ^{ab}	120.49±39.0 0 ^b
Concentrate	71.27±20.21 ^c	85.90±22.95 ^b	103.14±30.1 0 ^a
Total	222.58±66.5 0	217.84±59.1 0	223.63±69.1 0
% of forage intake on DMI (%)	67.89±0.56 ^a	60.48±1.37 ^b	53.62±1.20 ^c
<i>Crude Protein Intake, g/d</i>			
Forage	19.49±5.97 ^a	16.99±4.70 ^{ab}	15.52±5.02 ^b
Concentrate	13.54±3.84 ^b	16.32±4.36 ^{ab}	17.04±4.97 ^a
Total	33.03±9.81	33.31±9.01	32.56±9.99
<i>NDF Intake, g/d</i>			
Forage	96.60±29.60 ^a	84.27±23.31 ^a	77.00±24.90 ^b
Concentrate	37.29±10.57 ^c	47.50±12.68 ^b	56.94±16.60 ^a
Total	133.90±40.2 0	131.80±35.8 0	133.90±41.5 0
<i>Performance</i>			
Average daily gain or ADG (g/d)	12.24±9.04	11.43±3.71	17.69±10.77
Feed conversion ratio	25.26±15.43	18.91±4.17	16.50±11.40
Feed cost (PHP/d)	2.45±0.71	2.76±0.74	3.11±0.93
Feed cost per gain (PHP/g)	0.28±0.17	0.24±0.05	0.23±0.16

Notes: T1 is 72 : 28 NDF Forage-Concentrate Ratio; T2 is 64 : 36 NDF Forage-Concentrate Ratio; T3 is 57 : 43 NDF Forage-Concentrate Ratio; row means with different superscripts are significantly different ($p<0.05$).

Data on the rate of degradation of b in this experiment was relatively the same. Effect of different NDF ratios in the diets showed no significant effect on the rate of degradation of b ($p>0.05$). The mean of the rates of degradation of b from each treatment were 0.05, 0.03 and 0.05, respectively.

In this case, the rate of degradability diet treatment when seen from the data a, b and c with the parameters showed no differences in dry matter. If the same passage in the rumen was assumed, the rate of feed utilization and value of feed utilization by the rumen microbes were relatively similar. Comparing with the results of the study of Morais (2012), dry matter degradability in this experiment was higher than the samples of rain tree (0-100% from the diets) mixed with rice bran and copra meal. In his experiment, the average value of a was around 45.44%, b was 22.78% and c was around 0.07. In this present study, the value of a was 29.84%, b was 47.83%, and c was 0.04. Results of this study also descriptively showed that Treatment 2 had higher degradability compared to Treatments 3 and 1. The values were estimated using 48 hours as time of incubation with the result of DM

degradability in Morais (2012) at around 67.43% compared with 70.66% found in this experiment.

Similar levels of DM degradability in rumen in each treatment were probably caused by similar levels of NDF diets. Yulistiani *et al.* (2008) stated that the level of NDF diet affects DM degradability in the rumen and lower NDF diet results to higher DM degradability. If the result of dietary degradability in this experiment is compared with the *P. purpureum* that was cited by Januarti (2009), where *P. purpureum* was found to incubate during maximum time in rumen and had dry matter degradability of around 37.18%, the dietary DM degradability was higher (70.66%) during 48 hours incubation in this experiment. Wati *et al.* (2012) mentioned that results of other studies on *P. purpureum* degradability showed a range of only 49.10% during 48 hours incubation. This indicates that the higher DM degradability on dietary treatments was caused by lower content of NDF diets than *P. purpureum* in this study (Hartadi *et al.*, 2005; Januarti, 2009; Wati *et al.*, 2012 and Yulistiani *et al.*, 2008).

Different ratios of NDF from forage and concentrate in the diets used in this experiment did not affect the degradability of CP among the diets in 0 hours, potential degradability fraction of CP or b, and rate of degradation of b ($p>0.05$). Data on CP degradability of each treatment are shown in Table 5. This statement reinforces the claim that the capacity to digest the feed in the rumen is relatively the same on every treatment, and that the rate of degradability of CP in the diets is relatively equal and linear with degradability of DM and NDF diets, indicating no difference.

Degradability of CP diets on 0 hours were 43.33, 44.44 and 46.50%, respectively from Treatments 1, 2, and 3; whereas potentially degradable fractions of CP diets or b were 34.16% for Treatment 1, 32.39% for Treatment 2, and for Treatment 3 at around 43.30%. According to descriptive analysis, the highest rate of CP degradation of b in this experiment was on Treatment 1 at around 0.04 while Treatments 2 and 3 were in the similar level of around 0.03. Terramoccia *et al.* (2000) reported the CP degradability of concentrate on *in sacco* study has a value of around 19.3% for a, around 60% for b, and around 0.120/h for c. Compared with the study results by Morais (2012), CP degradability in this experiment was higher than the samples of rain tree (0-100% from the diets) mixed with rice bran and copra meal. In the experiment of Morais (2012), the time of incubation equals with 48 hours. The degradability of CP in this experiment was around 73.70% compared with his experiment which had a degradability of CP of around 66.60%. It means that the ratios of forage and concentrate in the diets used in this experiment were more effectively fermented in the rumen compared with the diets used by Morais (2012).

Feeding Trial

Different treatments were represented by the different ratios of neutral detergent fiber (NDF) from forage and concentrate in the diet. The data on dry matter (DM) intake (forage, concentrate and total intake), crude protein (CP) intake (forage, concentrate and total intake), NDF intake (forage, concentrate and total intake) and the ratio of forage in diets are shown in Table 5.

Treatments based on the different ratios of NDF from forage and concentrate in the diet caused the intake rate of forage and concentrates on the DM, CP and NDF to be

significantly different ($p<0.05$). However, the total intake of DM, CP and NDF were not significantly affected by differences in the ratios of NDF from forage and concentrate in the diets ($P>0.05$).

Dry matter intake (DMI) of forage in Treatment 1 (151.31 g/d) was greater than in Treatment 2 (131.94 g/d) and Treatment 3 (120.49 g/d), while the lowest concentrate intake was found in Treatment 1 (71.27 g/d), followed by Treatment 2 (85.90 g/d) and Treatment 3 (103.14 g/d). Total DMI in all treatments was relatively the same at 222.58, 217.84, and 223.63 g/d for Treatments 1, 2 and 3, respectively. Increase in DMI, especially of concentrates, further enhanced fermentation resulting in increased protein synthesis (Rotger *et al.*, 2006; Bourquin *et al.*, 1994). DMI was relatively uniform as described by Cantalapiedra-Hijar *et al.* (2009) that the diets were prepared to have the same palatability. Contrary to the results of this study, Haddad (2005) reported that DMI increased with increasing the concentrate portion and averaged 585, 630, and 676 g/d for the high forage, medium to high forage, and low forage diets at 60:40, 45:55 and 30:70 forage: concentrate ratios, respectively.

Crude protein intake from forage was higher in Treatment 1 (19.49 g/d), followed by Treatment 2 (16.99 g/d) and Treatment 3 (15.52 g/d). Meanwhile, the intake of crude protein from concentrate was found to decrease the largest in Treatment 3 (17.04 g/d), than at 16.32 g/d in Treatment 2, and Treatment 1 (13.54 g/d). Intake of total crude protein T1, T2 and T3 were relatively the same. This was due to the DMI which was relatively equal, the relatively similar total content of CP in the diets and the accumulation of CP intake supplied from forage and uniform concentrate in the range (32.56 to 33.31 g/d).

The same thing also happened with forage NDF. Based on the descriptive analysis, Treatment 1 had the highest intake (96.60 g/d), followed by Treatment 2 (84.27 g/d) and the last was in Treatment 3 (77.00 g/d) while the lowest intake of NDF concentrate was found in Treatment 1 (37.29 g/d), then Treatment 2 (47.50 g/d) and the highest level of intake was in Treatment 3 (56.94 g/d). NDF total intake in the diets was relatively the same in Treatments 1, 2 and 3 at 133.90, 131.80 and 133.90 g/d, respectively.

The data from forage and concentrate intake were converted to a ratio of forage in diets. Thus, the ratio of forage intake in the total intake or diets was higher in Treatment 1 (67.89%), while Treatment 2 had only a ratio of 60.48% while the lowest ratio was found in Treatment 3 (53.62%).

From the data above, it could be concluded that the quality of the diets in each treatment was relatively the same because the total intake of DM and their nutritional contents were relatively similar. It could also be assumed the diets used in this experiment had almost the same palatability. Feeds with good quality are usually consumed by animals in larger quantities compared to low-quality feed (Tillman *et al.*, 1984). The diets were formulated to contain the same amount of CP and energy based on the nutrient requirement of the animals. The content of NDF has been reported to affect the level of consumption through physical effects (filling effect) so it can be used as a variable in predicting consumption (Waldo, 1986; Merten, 1994). The results of the study of Coleman *et al.* (1999) also showed that the content of NDF and lignin accounted for only 56% of the variability in the amount of forage consumption studied. It is possible that the

NDF content in this experiment of around 58.94 to 60.65% was of the same level and was not able to influence the total consumption of nutrients.

From the performance of native goats given 3 kinds of diets with different ratios of NDF from forage and concentrate, average daily gain (ADG), feed conversion ratio (FCR), feed cost and feed cost per gain can be seen in Table 5. It is an important aspect to be considered, whether the treatments can be used to indicate significant differences in economic terms.

Differences in the ratios of NDF from forage and concentrate in the diets did not significantly affect the performance of the native goats ($p > 0.05$). The mean ADG in Treatments 1, 2, and 3 were 12.24, 11.43 and 17.69 g/d, respectively. The mean of FCR in Treatments 1, 2, and 3 were relatively similar, ranging from 25.26, 18.91 and 16.50. Weight gain of goats is sensitive to protein and energy content of forages (Ash and Norton, 1987). In contrast to the results of Haddad (2005), a linear increase was observed for ADG with increasing levels of dietary concentrates. Dønnem *et al.* (2011) reported that Norwegian dairy goats supplemented with a low (LC; 0.6 kg per goat daily) or normal (NC; 1.2 kg per goat daily) level of concentrate, had a body gain of around 25 vs 94 g during their experiment. In this present study, increasing the portion of concentrate did not affect the ADG of the goats. This was also supported by the equal DMI and total nutrients intake found between the treatments.

Economically, feed cost was cheaper in Treatment 1 (2.45 PHP/d), followed by Treatment 2 at a cost of 2.76 PHP/d, and the most expensive maintenance cost was contained in Treatment 3 which was equal to 3.11 PHP/d. However, feed cost per gain in each treatment had relatively the same range at 0.28, 0.24 and 0.23 PHP/g, respectively, in Treatments 1, 2, and 3. This result has a different pattern from Haddad (2005) who stated that kids fed with more proportion of concentrate had the lowest FCR than the kids fed with higher proportion of forage. Kids fed with the low forage (LF) diet had a lower feed to gain ratio (3.4) compared with kids fed with the medium to high forage (MHF) and medium to low forage (MLF) diet (average = 5.2). Kids fed the high forage (HF) diet had the highest feed to gain ratio (7.4). But in contrast with Haddad (2005), the result of feed cost as found in this experiment was reduced by increasing the levels of concentrates. Dietary treatment used in this experiment was more effective than the diets that were used by Morais (2012) which had a FCR of only around 22.54.

The ADG of 13.92 g/d obtained in this study indicates lower DMI of around 73.71 g/d and a shortage of TDN of around 7.59 g/d based on the nutritional requirement compiled by Kearl (1982). There was a surplus, however, at around 6.38 g/d for digestible protein. This indicates that tropical animals will require more energy and protein for maintenance based on the nutrition table for ruminants in temperate zone compiled by Kearl (1982). It is possible that the requirement for energy as TDN was supplied by the excess in digestible protein that was converted to energy from transformation of protein.

IV. CONCLUSION

Based on the interpretation of the data obtained in this study, different ratios of NDF in the diets had no effect on dry matter, crude protein, and NDF intake. This was supported by

dietary rumen degradability, which was the same among treatments. Feed intake of the different diets did not significantly affect the performance of native goats with an average ADG of 13.92 g/d and FC of native goats worth 20.30. Giving higher proportion of NDF concentrate based on the ratio of NDF in the diets had a higher production cost than other diets prepared with greater proportion of forage NDF. It had the same efficiency in feed cost per gain worth 0.25 PHP/g. This means that NDF from forage of 72% in the diets had the same feed utilization and growth performance when compared to NDF from forage of around 64% to 57% in the diets using higher portion of concentrate.

ACKNOWLEDGEMENTS

The author gratefully appreciates the support received from the Beasiswa Unggulan BPKLN Indonesia, Dr. Cesar C. Sevilla, Director of ADSC – UPLB, Prof. Dr. Sunarso MS - UNDIP, Dr. Ir. Paristiyanti Nurwardani, MP, Education Attache of Indonesian Embassy in Manila and faculty staff of master program in Animal Science (MIT) UNDIP. In addition, the expert advice of the reviewers for the improvement of this manuscript is sincerely appreciated.

REFERENCES

- [1]. AOAC. 1984. Official methods of analysis of the association of official analytical chemist. 14th ed. AOAC Inc. Arlington. Virginia.
- [2]. Ash AJ, Norton BW. 1987. Studies with the Australian cashmere goat. I. Growth and digestion in male and female goats given pelleted diets varying in protein and energy level. *Aus J Agric Res.* 38:957-969.
- [3]. Bourquin LD, Titgemeyer EC, Merchen NR, Fahey Jr GC. 1994. Forage level and particle size effects on orchardgrass digestion by steers: I. Site and extent of organic matter, nitrogen, and cell wall digestion. *J Anim Sci.* 72:746-758.
- [4]. Cantalapiedra-Hijar G, Yáñez-Ruiz DR, Martín-García AI, Molina-Alcaide E. 2009. Effects of forage: concentrate ratio and forage type on apparent digestibility, ruminal fermentation, and microbial growth in goats. *J Anim Sci.* 87:622-631.
- [5]. Chantaprasarn N, Wanapat M. 2008. Effects of sunflower oil supplementation in cassava hay based-diets for lactating dairy cows. *Asian-Aust. J Anim Sci.* 21:42-50.
- [6]. Coleman SW, Lippke H, Gill M. 1999. Estimating the nutritive potential of forages. In: *Nutritional Ecology of Herbivores*. In H.G. Jung, G.C. Fahey (Eds.) American Society of Animal Science, Savoy, IL. USA. p. 647-695.
- [7]. Dønnem, I., Å.T. Randby and M. Eknæs. 2011. Effects of grass silage harvesting time and level of concentrate supplementation on nutrient digestibility and dairy goat performance. *Animal Feed Science and Technology* 163 (2011) 150–160.
- [8]. Gaspersz V. 1991. Method of experiment design. Bandung: CV. Armico.
- [9]. Haddad SG. 2005. Effect of dietary forage:concentrate ratio on growth performance and carcass characteristics of growing Baladi kids. *Small Ruminant Res.* 57:43-49.
- [10]. Hartadi H, Reksohadiprodjo S, Tillman AD. 2005. Tables of feed composition for Indonesia. Gadjah Mada University Press, Yogyakarta.
- [11]. Isah OA, Babyemi OJ. 2010. Nutrient degradability and performance by the West African Dwarf Goats fed rumen epithelium - based diets. *J Agr Sci Tech.* 12:289-297.
- [12]. Januarti R. 2009. Total gas production and degradability of tropical browse plants using sheep rumen fluid which fed contain saponin and tannin. Undergraduate thesis. Department of Animal Science and Technology. Bogor Agriculture University. Unpublished.
- [13]. Kanjanapruthipong J, Buatong , Buaphan S. 2001. Effects of roughage neutral detergent fiber on dairy performance under tropical conditions. *Asian-Aust J Anim Sci.* 10:1400-1404.
- [14]. Kearl LC. 1982. Nutrient requirements of ruminants in developing countries. International Feedstuffs Institute, Utah Agricultural Experiment Station, Utah State University. Logan, Utah.
- [15]. Merten DR. 1994. Regulation of forage intake. In: *Forage Quality, Evaluation, and Utilization*. Fahey Jr GC, editors. American Society of Agronomy, Crop Science Society of America, Soil Science Society of America. Madison, Wisconsin, USA. p. 450-493.

- [16]. Moon YH, Lee SC, Lee SS. 2004. Effects of neutral detergent fiber concentration and particle size of the diet on chewing activities of dairy cows. *Asian-Aust J Anim Sci.* 11:1535-1540.
- [17]. Morais JM. 2012. Nutritive Value of Rain Tree [Samanea Saman (Jacq.) Merr] Pods for Philippine Native Goats (*Capra hircus* Linn.). Thesis of Master in Animal Science. University of The Philippines, Los Banos.
- [18]. NRC. 1988. Nutrient Requirements of Dairy Cattle: Sixth Revised Edition. National Academy Press, Washington DC.
- [19]. NRC. 2001. Nutrient requirements of dairy cattle: 7th revised ed. National Academy Press, Washington DC.
- [20]. Osuji PO, Nsahlai IV, Khalili H. 1993. Feed evaluation. International Livestock Centre for Africa, Addis Ababa, Ethiopia.
- [21]. Ørskov ER, DeB Hovell FD, Mould F. 1980. The use of the nylon bag technique for the evaluation of feedstuffs. *Trop Anim Prod.* 5:195-213.
- [22]. Rotger A, Ferret A, Calsamiglia S, Manteca X. 2006. *In situ* degradability of seven plant protein supplements in heifers fed high concentrate diets with different forage to concentrate ratio. *Anim Feed Sci Technol.* 125:73-87.
- [23]. Sutardi T. 2001. Revitalizing the dairy farm through the use of waste-based plantation diets and organic mineral supplementation. Research Report VIII. Institut Pertanian Bogor, Bogor. Unpublished.
- [24]. Tafaj M, Kolaneci V, Junck B, Maulbetsch A, Steingass H, Drochner W. 2005. Influence of fiber content and concentrate level on chewing activity, ruminal digestion, digesta passage rate and nutrient digestibility in dairy cows in late lactation. *Asian-Aust J Anim Sci.* 8:1116-1124.
- [25]. Terramoccia S, Bartocci S, Amici A, Martillotti F. 2000. Protein and protein-free dry matter rumen degradability in buffalo, cattle and sheep fed diets with different forage to concentrate ratios. *Livest Prod Sci.* 65:185-195.
- [26]. Tillman AD, Hartadi H, Reksohadiprodjo S, Prawirokusumo S. Lebdosoekojo S. 1984. Food animal science association. Prints to-5. Gadjah Mada University Press, Yogyakarta.
- [27]. Van Soest JP, Robertson JB, Lewis BA. 1991. Symposium : Carbohydrate methodology, metabolism, and nutritional implications in dairy cattle. *J Dairy Sci.* 74:3583-3597.
- [28]. Waldo DR. 1986. Effect of forage quality on intake and forage-concentrate interaction. *J Dairy Sci.* 69:617.
- [29]. Wati NE, Achmadi J, Pangestu E. 2012. *In sacco* ruminal degradation of nutrients of agricultural by-products in the goat. *J Anim Agricul.* 1:485-498.
- [30]. Yulistiani D, Jelan ZA, Liang JB. 2008. Degradability of mulberry (*Morus alba*) and rice bran in the rumen of sheep fed different diets. *JITV* 13:264-272.