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

Nugroho D[1], Sevilla CC[1], Angeles AA[1], Sunarso[2]

[1]*Animal Science and Dairy Cluster, University of the Philippine Los Baños*
E-mail: abecede_koko@yahoo.com
[2]*Faculty of Animal Science and Agriculture, Diponegoro University, Semarang*

(Diterima 5 September 2013 ; disetujui 8 November 2013)

ABSTRAK

Nugroho D, Sevilla CC, Angeles AA, Sunarso. 2013. Pengaruh rasio neutral detergent fiber di dalam pakan terhadap rumen degradabilitas dan performa pertumbuhan kambing lokal Filipina (*Capra hircus* Linn.). JITV 18(4): 291-300. DOI: 10.14334/jitv.v18i4.336.

Tujuan penelitian ini untuk menentukan rumen degradabilitas pakan dan performa pertumbuhan kambing. Delapan belas (18) kambing betina lokal dikelompokkan menjadi 6 kelas untuk percobaan, rata-rata bobot badan hewan yang digunakan adalah sekitar 7,96 ± 2,21 kg (CV = 27,76%) dan umur sekitar 1 tahun, digunakan untuk *feeding trial.* Penelitian kecernaan *in situ* menggunakan tiga (3) kambing jantan dewasa yang dilengkapi dengan *rumen cannulated.* Tiga (3) diet treatment yang merupakan rasio NDF pakan-konsentrat digunakan untuk semua studi sebagai berikut: T1 - 72: 28; T2 - 64: 36; T3 - 57: 43. Rancangan acak kelompok yang diaplikasikan untuk *feeding trial* dan 3 x 3 LSD digunakan dalam *in situ* studi. Treatment 1, 2 dan 3 tidak mempengaruhi laju degradasi rumen DM, NDF dan CP pada 0 jam, fraksi berpotensi terdegradasi (b) dan laju degradasi b. Rasio yang berbeda NDF hijauan dalam diet mempengaruhi tingkat konsumsi hijauan dan konsentrat pada DM, CP dan NDF. Namun, total konsumsi DM, CP dan NDF tidak terpengaruh oleh perbedaan rasio NDF hijauan dalam pakan. Performa kambing yang digunakan tidak dipengaruhi oleh perlakuan, menghasilkan produksi dan efisiensi yang sama. Ini berarti bahwa pakan yang diberikan kepada kambing lokal dengan NDF hijauan ransum 72,07% dapat diterapkan karena nilai output dan efisiensi pemanfaatan pakan memiliki nilai yang sama bila dibandingkan dengan pakan yang menggunakan rasio NDF hijauan pakan ternak 57,21%.

Kata Kunci: NDF Hijauan, Rasio, Kambing

ABSTRACT

Nugroho D, Sevilla CC, Angeles AA, Sunarso. 2013. The effects of dietary neutral detergent fiber ratio on the rumen degradability and growth performance of Philippine native goats (*Capra hircus* Linn.). JITV 18(4): 291-300. DOI: 10.14334/jitv.v18i4.336.

This research's objective was to determine the dietary rumen degradability and growth performances of goats fed dietary treatments. Eighteen (18) female goats were grouped into 6 weight classes for the feeding trial experiment, the average BW of the animals that were used was about 7.96 ± 2.21 kg (CV - 27.76%) and were approximately 1 year of age. For the *in situ* digestibility, three (3) male mature goats surgically fitted with cannulated rumen were used. Three (3) dietary treatments were used for all studies as follows: T1 - 72 : 28 NDF Forage-Concentrate Ratio; T2 - 64 : 36; T3 - 57 : 43. A RCBD was applied for Feeding Trial and a 3 x 3 LSD was used for *In Situ* Study. Treatments 1, 2 and 3 did not affect the rate of rumen degradability of DM, NDF and CP at 0 hours, potentially degradable fraction (b) and the rate of degradation of b. The treatments affected the intake rate of forage and concentrates on the DM, CP and NDF. However, the total intake of DM, CP and NDF were not affected by the treatments. Growth performance of goats used in this experiment was not affected by the treatments as indicated by the similar production and efficiency. This means that diets given to native goats with ratio of NDF forage 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 NDF forage of 57.21%.

Key Words: NDF Forage, Ration, Goat

INTRODUCTION

One of the steps to be taken is in the improvement of feeding management that done by the farmers are using high ration of concentrates compared with forage in the diets. Although it has a positive impact on production from an economic standpoint, the use of excessive concentrate will lead to an increase in production cost (Yulistiani et al. 2008). Approximately 60% of the cost of production especially in milk production can be attributed to the concentrates fed to the animals (Chantaprasarn & 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 NDF forage in the ration also plays a role in ruminant production. It is associated with chewing activity, saliva production, fermentation rate and yield, and digestibility of feed. Chewing time is highly influenced by NDF content, compared 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 of ruminant and to maintain health by sustaining a stable environment in the rumen (Tafaj et al. 2005). Study of managing ratio of NDF in the diets and its effect is lacking of data, especially in tropical areas. But generally, concentration of NDF in the diets negatively relates DMI, feed digestibility, performance of animal (Parakkasi 1999; Luginbuhl et al. 2000; Molina-Alcaide et al. 2000, Agle et al. 2010, Lascano et al. 2008), as describe by Luginbuhl et al. (2000) DMI, CP intake and ADG decreased linearly with increasing whole cottonseed in the diet.

The level and ration 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 ration of forage and concentrate of the diet should contain around 75% of NDF forage 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 NDF forage (75% to 60%) in the diet still provides sufficient utilization of fiber for production and maintains fat corrected milk (Kanjanapruthipong et al. 2001). It is important to observe and evaluate the impact of the ration of NDF forage in the diets as recommended by NRC, with some adjustment based on the tropical condition and practical habits in the farm.

The main objective of this research is to determine the optimum feed utilization based on rumen degradability and growth performances of Philippine native goats (*Capra hircus* Linn.) fed diets containing different ratios of NDF from forage and concentrate in the diets.

MATERIALS AND METHODS

Materials

Eighteen (18) native female goats were grouped into 6 weight classes for the feeding trial experiment. It was conducted during 1.5 months (December 15th, 2012 to February 1st, 2013. 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 the *in situ* digestibility, three (3) male of mature goats that surgically fitted with cannulated rumen were used.

Treatments

The dietary treatments were composed from *P. Purpureum* as source of forage, commercial concentrate mixture, urea and molasses. The nutrient composition of *P. Purpureum* as forage and a commercial concentrate mixture used in the experiment is shown in Table 1. As treatments, NDF forage-concentrate ratio was used by managing the proportion of NDF forage and concentrate in the diets that stated in the percentage (%), explained in Table 2.

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

The ratios of NDF from forage to concentrate in the diets were calculated based on the total amount of NDF diets that supplied from a forage and concentrates. 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 2.

The dietary nutrient content of the treatments are shown in Table 3. The dietary crude protein (13.71±0.14%) and total digestible nutrients (TDN) (66.61±4.81%) used in study 1, 2 and 3 were formulated to be equal between the treatments. The diets were designed to be isocaloric and isonitrogenous by using urea and molasses. TDN content of *P. Purpureum* (NP) was estimated using the formulation that used by Sutardi (2001) and converted based on the total amount of TDN on digestibility study. Equation of TDN[1] was used for measuring TDN content of *P. Purpureum*. TDN[1] = 70.6 + (0.259xCP) + (1.01xEE) – (0.760xCF) + (0.0991xNFE).

Table 1. Nutrient content of feed ingredients

Ingredients*	CP	EE	CF	ASH	NFE	NDF
	................................%...					
P. Purpureum[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

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

Table 2. Composition of feed ingredients (%) and the proportion or level of NDF from forage and concentrates in the dietary treatments

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

Table 3. Nutrient contents of treatment diets (%)

Nutrient contents	NP	D1	D2	D3
DM	100.00	100.00	100.00	100.00
CP	12.88	13.54	13.81	13.77
TDN	56.64[1]	65.93	65.55	68.37
NDF	63.87	58.94	60.14	60.65
EE	1.44	2.19	2.73	3.28
CF	29.32	19.98	20.39	19.17
ASH	18.40	14.15	13.62	13.14
NFE	35.64	48.19	47.78	48.93

NP = Napier grass or *Pennicetum purpureum*;
D = 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;
TDN = value based on the equation from Sutardi (2001)

Methods

Experimental design

A randomized complete block design (RCBD) was applied for Feeding Trial and a 3 x 3 latin square design was used for *In Situ* Study.

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) 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 weighed to obtain initial body weight. Stage of application of treatment was the final step wherein feeds were given as much as 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 content of dietary treatments were analyzed using proximate analysis (AOAC, 1984) and NDF analysis, following procedure of 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 & 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 & 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.

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. The various post-incubation residual samples were grounded through a 1 mm screen for neutral detergent fiber (NDF) and crude protein determination.

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

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

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.

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

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

The degradability of DM, CP, and NDF were measured using the formula above. Analysis was done using Naway’s Microsoft Office 2003 to estimate the degradability (value of a, b, and c) based on the procedure that stated by Osuji et al (1993).

Data analysis

The data were analyzed using analysis of variance (ANOVA). Then the data was tested with a ANOVA according to the method of Gaspersz (1991), if there were significant different between treatments, then followed by Tukey's test with error level (α) 5%. The MINITAB 14 was used for running analysis of variance and Tukey’s test for other analyses if necessary.

RESULTS AND DISCUSSIONS

In situ study

Data on dry matter (DM) degradability, NDF degradability and crude protein (CP) degradability in the rumen are presented in Table 4. Dry matter degradability at 0 hour (a), or degradability after washing nylon bag is shown in Table 4. Treatments 1, 2 and 3 did not affect the rate of degradability of dry matter at 0 hours ($p > 0.05$). Levels of b or potentially degradable fraction of dry matter degradability on each treatment showed no difference ($p > 0.05$). This indicates that potentially degradable fraction of each treatment was relatively similar. Data on the rate of degradation of b in this experiment was relatively the same. Effect of different NDF ratios in the diet treatment showed no effect on the rate of degradation of b ($p > 0.05$). The mean of the rate of degradation of b from each treatment were 0.05, 0.03 and 0.05, respectively.

Table 4. Rumen pH, percentage of dry matter (DM) degradability, NDF degradability and crude protein (CP) degradability

In Situ's Parameters	T1	T2	T3
Dry Matter Degradability			
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
Neutral Detergent Fiber (NDF) Degradability			
a or intercept	4.57±3.14	7.88±7.27	9.07±6.17
b or potentially degradable fraction	57.28±7.66	62.43±10.23	57.48±7.76
c or rate of degradation of b	0.04±0.02	0.03±0.00	0.04±0.02
Crude Protein (CP) Degradability			
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

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 showed that Treatment 2 had higher degradability compared to Treatments 3 and 1. The values were estimated using 48 hours 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 level of DM degradability in rumen in each treatment was probably caused by similar level of NDF diets. Yulistiani et al. (2008) stated level of NDF diet affects DM degradability in the rumen, lower NDF diet results higher DM degradability. Explained by Karuse et al. (2002), similar feed's degradability might be resulted from similar amount of secreted saliva, rumen pH, rate of digesta, residence time and retention of feed in the rumen. That aspects could directly stimulate the intake and performance of the goats in this study. If the result of dietary degradability in this experiment is compared with the *P. purpureum* that was cited from Januarti et al. (2009), where *P. purpureum* was found to incubate during maximum time in rumen and had dry matter degradability of around 37.18%, in this experiment, the dietary DM degradability was higher (70.66%) during 48 hours incubation. 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. It shown that higher DM degradability on dietary treatments comparing with *P. purpureum* was caused by lower content of NDF diets in this study than *P. purpureum* (Hartadi et al. 2005; Januarti et al. 2009; Wati et al. 2012; Yulistiani et al. 2008).

NDF degradability in this experiment on each treatment was not affected by the ratios of NDF from forage and concentrate in the diets ($p > 0.05$). Data of NDF degradability (a, b and c) are shown in the Table 4. NDF degradability rate in this study was linear with dry matter degradability. This suggests that the rate of degradability of diet on each treatment was relatively the same and it was possible to cause a similar digestibility rate and passage rate of the diets in the rumen. This results also confirmed that similar degradability of the diets in the rumen especially NDF content were supported by the similar level of NDF in the diets as explained by Yulistiani et al. (2008).

The NDF degradability on each treatment at 0 hours was not significantly different ($p > 0.05$). Equal level of degradability indicated by the potentially degradable fraction of NDF in each treatment showed to be relatively similar. Similar to the data on the rate of degradation of b, this experiment also supported the assumption of similar degradability. Effect of different ratios in the diet NDF showed no effect on the rate of degradation of b ($p > 0.05$). When the diet contains 100% *P. Purpureum*, the dietary NDF degradability will just range around 40.89% (Wati et al. 2012).

DM and NDF degradability were relatively uniform in all treatments in this study. This was due to the diets was formulated in iso protein which caused in similar ruminal pH condition and rumen fibrolytic activity in digesting NDF (Rotger et al. 2006) the higher portion cell wall in the diet will resulted in lower NDF degradability (Lindberg 1985) such as in Treatment 1 which have more portion of forage. A higher concentrate portion in the diet will resulted in the increase of the diet degradability (Lindberg 1985; Terramoccia et al. 2000). However in this study DM and NDF degradability was not affected by the proportion of forage or concentrate in the diet. This might be caused by the rate of the degradation that is affected by endogenous protease in diets, urea enriching the proteolytict bacteria and stimulates activity of microba rumen (Theodorou 1995).

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 can be seen in Table 4. Those statement reinforces that the diets in this study had the similar capacity to digest feed in the rumen and similar rate of CP degradability that in line with DM and NDF degradability.

Degradability of CP diets on 0 hours and potentially degradable fractions of CP diets or b were not significantly different ($p > 0.05$). Descriptively, 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 situ* study has a value of around 19.3% for a, around 60% for b, and around 0.120h^{-1} for c. Compared to results from 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), at incubation for 48 hours reported CP degradability 66.60%. The degradability of CP in this experiment was around 73.70%. It means that the ratios of forage in the diets used in this experiment were more effectively fermented in the rumen compared with the diets used by Morais (2012).

Feeding Trial

Feeding trial in this study used similar feed composition to the diets used in *in situ* study. Different treatments were represented by the different ratios of NDF from forage and concetrate in the diet. The data on dry matter intake (forage, concentrate and total intake), crude protein 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.

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

Parameters	T1	T2	T3
Dry Matter Intake, g/d			
Forage	151.31±46.40^{a}	131.94±36.50^{ab}	120.49±39.00^{b}
Concentrate	71.27±20.21^{c}	85.90±22.95^{b}	103.14±30.10^{a}
Total	**222.58±66.50**	**217.84±59,10**	**223.63±69.10**
% of forage intake on DMI (%)	67.89±0.56^{a}	60.48±1.37^{b}	53.62±1.20^{c}
Crude Protein Intake, g/d			
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**
NDF Intake, g/d			
Forage	96.60±29.60^{a}	84.27±23.31^{ab}	77.00±24.90^{b}
Concentrate	37.29±10.57^{c}	47.50±12.68^{b}	56.94±16.60^{a}
Total	**133.90±40.20**	**131.80±35.80**	**133.90±41.50**
Performance			
Average daily gain or ADG (g/d)	12.24±9.04	11.43±3.71	17.69±10.77
Feed conversion	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

ns = Not significant with ($p>0.05$); and * = Significant with ($p < 0.05$) with different superscripts within rows denote significant differences

Different ratios of NDF from forage and concentrate in the diet caused the intake rate of forage and concentrates on the dry matter, crude protein and NDF to be different ($p < 0.05$). However, the total intake of dry matter, crude protein and NDF were not affected by differences in the ratios of NDF from forage and concentrate in the diets ($p > 0.05$).

Dry matter intake 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 dry matter intake in all treatments were relatively the same at 222.58, 217.84, and 223.63 g/d for Treatments 1, 2 and 3, respectively. Similarity in DMI, further caused uniform fermentation that resulting in similar protein synthesis in the rumen (Rotger et al. 2006; Bourquin et al. 1994). Uniform DMI was caused by the equal palatability of the diets as described by Cantalapiedra-Hijar et al. (2009) that similar palatability of the diets cause an equal DMI. Contrary to the results of this study, Haddad (2005) reported that dry matter intake 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), then 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 dry matter intake 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 equal intake of CP was caused by the content of CP in the diets arranged isoprotein (Parakkasi 1999) and using benefit of managing the ratio of NDF from forage and concentrate in the diets (Beachemin 1991 cited by Moon et al. 2004; Tafaj et al. 2005; Kanjanapruthipong et al. 2001).

The same thing also happened with NDF forage intake. Based on the descriptively, 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), and the highest level of intake was in Treatment 3 (56.94 g/d). NDF total intake in the diets were relatively the same in Treatments 1, 2 and 3 at 133.90, 131.80 and 133.90 g/d, respectively.

From the data above, it could be concluded that the quality of the diets on each treatment was relatively similar because the total DMI and their nutrients 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 animal in larger quantities compared to low-quality feed (Tillman et al. 1984). The diets were arranged to fullfil their requirements and were composed as isoprotein and isoenergy or isocaloric.

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. Similar total intake (DM, CP and NDF) was observed in this study in line with study of Kozloski et al. (2007) that shown supplementing non forage carbohydrates or (NFC) and combining with suplementation of RDP (like NPN) were not affecting th total intake or basal diet intake. This study also had similar resulted with Ginting et al. (2012), no difference in DMI of goats fed complete feed composed from *I arrecta* and supplemented concentrates aroudn 15 to 35%.

From the performance of native goats given 3 kinds of diets with different ratios of NDF from forage and concentrate, the aspect of average daily gain (ADG), feed conversion (FC), feed cost and feed cost per gain can be seen. The treatments arranged in this study can be used to indicate significant differences in economical value, which is an important aspect need to be considered. The data are presented in Table 5.

Differences in the ratios of NDF from forage and concentrate in the diets did not 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 feed conversion 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 & Norton 1987). In contrast to this study of Haddad (2005) reported that 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 concentrate (LC; 0.6 kg per goat daily) or normal concentrate (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 might be caused by the equal DMI and total nutrients intake found between the treatments. Similar degradability of nutrients content in the diets on rumen also explained the similar performance on ADG. 60% nutrients that absorbed and utilized for production come from nutrients feed fermented in the rumen by rumen microbia (Arora 1995).

When viewed from the maintenance cost, 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 FC than the kids fed with higher proportion of forage. Kids fed with the low forage (LF) diet had a lower feed: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), to 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 feed conversion of only around 22.54.

The ADG range of 13.92 g/d obtained in this study indicates a shortage of DMI by around 73.71 g/d and a shortage of TDN by around 7.59 based on the table of nutrients requirement of Kearl (1982). There was also a surplus around 6.38 g/d for digestible of protein (Kearl 1982). 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 suplied by the excess in digestible protein that was converted to energy from transformation of protein.

CONCLUSIONS

The effect of differences in the ratio of NDF in the diets had no effect on dry matter, crude protein, and NDF intake of the diets. Similarity in the utilization of diets was shown by the uniformity of degradability rate between diets. Similar feed intake dietary treatments resulted no significant effect on the performance of native goats with an average ADG of 13.92 g/d and FC of 20.30. Giving higher concentrate based on the ratio of NDF in the diets, caused higher production cost than other diets contained greater proportion of forage. Morever, it was not beneficial for the management, because it had the same efficiency in feed cost per gain of 0.25 PHP/g.

Ratio NDF forage of 72% in the diets using higher portion of forage had the same feed utilization and growth performance compared to ratio NDF forage of around 64% to 57% in the diets using higher portion of concentrate. The ratio of 72% NDF forage in the diet can be applied in formulating a ration since the value of the output and efficiency of feed utilization had the same value compared with diets to ratio of NDF forage at 57%.

ACKNOWLEDGEMENTS

The author gratefully appreciates the support received from the Beasiswa Unggulan BPKLN Indonesia, Dr. Cesar C. Sevilla (UPLB) and Dr. Ir. Paristiyanti Nurwardani, MP. In addition, the expert advise from the reviewers for the improvement of this manuscript is sincerely appreciated.

BIBLIOGRAPHY

Agle M, Hristov AN, Zaman S, Schneider C, Ndegwa PM, Vaddella VK. 2010. Effect of dietary concentrate on rumen fermentation digestibility and nitrogen losses in dairy cows. J Dairy Sci. 93:4211-4222.

AOAC. 1984. Official methods of analysis of the association of official analytical chemist. 14th ed. AOAC Inc. Arlington. Virginia.

Arora SP. 1995. Microbial digestion in the ruminant. Yogyakarta (Indones): Gadjah Mada University Press.

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. Aust J Agric Res. 38:957-969.

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.

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.

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.

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.

Dønnem I, Randby ÅT, Eknaes M. 2011. Effects of grass silage harvesting time and level of concentrate supplementation on nutrient digestibility and dairy goat performance. Anim Feed Sci Technol. 163:150-160.

Gaspersz V. 1991. Method of experiment design. Bandung (Indones): CV Armico.

Ginting SP, Tarigan A, Krisnan R. 2012. Consumption, ruminal fermentation and blood metabolites of growing goats fed ensiled *I. Arrecta* in complete diets. JITV. 17:49-58.

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.

Hartadi H, Reksohadiprodjo S, Tillman AD. 2005. Tables of feed composition for Indonesia. Yogyakarta (Indones): Gadjah Mada University Press.

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.

Januarti R. 2009. Total gas production and degradability of tropical browse plants using sheep rumen fluid which fed contain saponin and tannin (S2 thesis). [Bogor (Indones)]. Bogor Agriculture University.

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.

Karuse KM, Combs DK, Beauchemint KA. 2002. Effects of forage particle size and grain fermentability in mid-lactation cows. I. Milk production and diet digestibility. J Dairy Sci. 85:1936-1946.

Kearl LC. 1982. Nutrient requirements of ruminants in developing countries. International Feedstuffs Institute, Utah Agricultural Experiment Station, Utah State University. Logan, Utah.

Kozloski GV, Reffatti MV, Bonnecarrère Sanchez LM, Lima LD, Cadorin Jr RL, Härter CJ, Fiorentini G. 2007. Intake and digestion by lamb as fed a low-quality grass hay supplemented or not with urea, casein or cassava meal. Anim Feed Sci Technol. 136:191-202.

Lascano GJ, Zanton GI, Moody ML, Topper PA, Wheeler EF, Heinrichs AJ. 2008. Short communication: Effect of changing the ratio of forage to concentrate on ammonia emissions by dairy heifers. J Dairy Sci. 91:4301-4306.

Lindberg JE. 1985. Retention time of chromium-labelled feed particles and of water in the gut of sheep given hay and concentrate at maintenance. Br J Nutr. 53:559-567.

Luginbuhl JM, Poore MH, Conrad AP. 2000. Effect of level of whole cottonseed on intake, digestibility, and performance of growing. J Anim Sci. 78:1677-1683.

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.

Molina-Alcaide E, Martín-García AI, Aguilera JF. 2000. A comparative study of nutrient digestibility, kinetics of degradation and passage and rumen fermentation pattern in goats and sheep offered good quality diets. Livest Prod Sci. 64:215-223.

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.

Morais JM. 2012. Nutritive value of Rain Tree [*Samanea saman* (Jacq.) Merr] Pods fpr Philippine Native Goats (*Capra hircus Linn*.) (S2 thesis). [Los Banos (Philippines)]: University of The Philippines, Los Banos.

NRC. 1988. Nutrient requirements of dairy cattle: 6th revised edition. Washington DC (USA): National Academy Press.

NRC. 2001. Nutrient requirements of dairy cattle: 7th revised ed. Washington DC (USA): National Academy Press.

Osuji PO, Nsahlai IV, Khalili H. 1993. Feed evaluation. Internasional Livestock Centre for Africa, Addis Ababa, Ethiopia.

Parakkasi, A. 1999. Animal nutrition and food science for ruminants. Jakarta (Indones): Indonesia University Press.

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.

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.

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.

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.

Theodorou MK. 1995. Digestion kinetics of ruminant feeds and plant enzyme mediated proteolysis in ruminants. In Conference on Rumen Function. 23. Chicago, Illinois November 14-16.

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.

Tillman AD, Hartadi H, Reksohadiprodjo S, Prawirokusumo S. Lebdosoekojo S. 1984. Food animal science association. Prints to-5. Yogyakarta (Indones): Gadjah Mada University Press.

Van Soest JP, Robertson JB, Lewis BA. 1991. Symposium : Carbohydrate methodology, metabolism, and nutritional implications in dairy cattle. J Dairy Sci. 74:3583-3597.

Waldo DR. 1986. Effect of forage quality on intake and forage-concentrate interaction. J Dairy Sci. 69:617.

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.

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.