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Evaluation Of Digestibility Value And Rumen Fermentation Kinetic Of Goat's Local Feed-Based Ration

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ABSTRACT: Digestibility is an indication of the presence of nutrient available in the feed ingredient consumed by livestock. The quality of nutrient is determined by the level of digestion of the food substances absorbed in the digestive tract. This research aimed to evaluate the dry matter digestibility (DMD), organic matter digestibility (OMD), concentration of volatile fatty acid (VFA) and N-NH_3 with the addition of local feed Supan-supan (Neptunia plena L. Benth) and Kolomento (Leersia hexandra Swartz). The reseach was conducted on January 2018 in Animal Feed and Nutrition Laboratory of Animal Husbandry and Agriculture Faculty, Diponegoro University, Semarang. The research method used in vitro analysis with completely randomized design with five treatments is T_1 (Leersia hexandra Swartz 100 %); T_2 (Neptunia plena 100%); T_3 (Leersia hexandra 15%+(Neptunia plena L. Benth 15%+70% Other Feedstuffs); T_4 (Leersia hexandra 20%+(Neptunia plena 20% + 60% Other Feedstuffs); T_5 (Leersia hexandra Swartz 25% + (Neptunia plena L. Benth 25%+50% Other Feedstuffs). The data were analyzed with analysis of variance at 95% significant level, followed by Duncan Multiple Range Test. The resource results showed that the treatment had significant impact ($P<0.05$) to KcBK, KcBO, N-NH_3, and VFA. The results indicated that T_3 has the best KcBK and KcBO 40.13% and 46.63%. The best production of N-NH_3 contained in T_2=8.18 mM and the best VFA T_5=50.21 mM. It was concluded that use of local feedstuffs by quantity can contribute to the production of goats.

Keywords: Ration, local feed, in vitro, digestibility, dry matter, organic matter

ABSTRAK

Kecernaan merupakan indikasi ketersediaan nutrien dalam bahan pakan yang dikonsumsi oleh ternak. Kualitas nutrien ditentukan berdasarkan tingkat kecernaan zat makanan yang diserap dalam saluran pencernaan. Penelitian bertujuan untuk mengevaluasi kecernaan bahan kering (KcBK), kecernaan bahan organik (KcBO), konsentrasi *Volatile fatty acid* (VFA) serta N-NH_3 ransum dengan penambahan pakan lokal Supan-supan (*Neptunia plena* L. Benth) dan Kolomento (*Leersia hexandra* Swartz). Penelitian dilaksanakan pada bulan Januari 2018 di Laboratorium Ilmu Nutrisi, dan Makanan Ternak Fakultas Peternakan dan Pertanian Universitas Diponegoro Semarang. Metode Penelitian yang digunakan adalah analisis *in vitro* dengan rancangan acak lengkap (RAL) lima perlakuan yaitu T_1 (Kolomento 100 %); T_2 (Supan-supan 100%); T_3 (Kolomento 15%+Supan-supan 15%+70 % Bahan lain); T_4 (Kolomento 20%+Supan-supan 20%+60% Bahan lain); T_5 (Kolomento 25%+Supan-supan

25%+50% Bahan lain). Data penelitian dianalisis menggunakan Analisis Variansi (ANOVA) taraf 95% untuk mengetahui perbedaan antara perlakuan dan dianalisis lanjut menggunakan *Duncan's Multiple Range Test* (DMRT). Hasil penelitian memperlihatkan bahwa perlakuan berpengaruh nyata (P<0,05) terhadap KCBK, KCBO, N-NH_3, dan VFA. Hasil uji lanjut menunjukkan bahwa perlakuan T_3 memiliki KcBK dan KcBO terbaik 40,13% dan 46,63%. Produksi N-NH_3 terbaik terdapat pada T_2=8,18 mM dan VFA terbaik pada T_5=50,21 mM. Kesimpulan yang diperoleh yaitu penggunaan bahan pakan lokal secara kuantitas mampu memberikan kontribusi terhadap produksi kambing.
Kata Kunci: Ransum, pakan lokal, *in vitro,* kecernaan, bahan kering, bahan organik

1. INTRODUCTION

Livestock industry has important contribution to agriculture industry by providing meat and milk as income source to farmers, however the productivity hasn't optimum yet. This is closely related to insufficient feed supply, genetic quality of the breeding and fault in the raising system (Khanum *et al*., 2007). Ruminant is a livestock commodity that can utilize a low feedstuffs quality and high crude fiber and then digests into quality feed (Lunagariya et al*.,* 2017). Quality feed is an important factor to fulfill livestock growth needs to achieve maximum meat production and to achieve a successful livestock business (Yakin et al*.,* 2012). Goat has important contribution to small farmers because the price is relatively affordable and easy to maintance. The population of goat in East Kalimantan in 2016 was 57.794 heads (Ministry of Agriculture, 2017).

The feed that given to goat should consider the availability thus local feedstuffs which cheap, easy to get, and abundant availability throughout the year. Utilization of local feedstuffs can reduce the feed cost thus it can makes more profit to farmers. Local feed is any raw materials originating from local Indonesian resources that have potential to be used efficiently as feed by goats as a supplement, concentrate component or basal feed (Ginting, 2005).

The local plant that has potential to be utilized by goat to fulfill their nutritional needs is Supan-supan (*Neptunia plena* L. Benth) and Kolomento (*Leersia hexandra* Swartz). *Neptunia plena* L. Benth is a semi-aquatic legume belong to the family of Fabaceae, rooted, the trunk forms a fibrous sponge so that it can grows on the surface of the water (floating), and compound leaves (The Queensland Government, 2016; Natural Resources Conservation Service, 2017; National Parks, 2017). The combination of legumes and grass can increased the diversity of nutrients in the feed. Kolomento grass has habitat in the water, breeding using rhizome roots and stolons in the form of upright and hollow stems, generally floating on the surface of the water (Liu et al., 2011). *Neptunia oleracea* substitution in ruminant ration of 7.5% obtained DMD, OMD, N-NH_3, VFA respectively 59.51%; 56.58%; 5.63 mM; and 80.62 mM (Riswandi et al., 2017).

Feed digestibility is an important indicator to be use as a guide to determine the nutrient amount of the feeds that able to absorbed by digestive tract. In vitro is a widely-used feed evaluation technique to ruminant, easy to get the result, less animal sample used, and cheaper compared with in vivo technique (Aderinboye et al., 2016). The nutrient content of ration can be determined based on the chemical composition of the ration, while the use of nutrient can be determined by digestibility test and the level of biological fermentation through in vitro method (Khanum et al., 2007), therefore this research aimed to evaluate the digestibility value and fermentation level of goat's local feed-based ration.

2. MATERIAL AND METHOD

The research was conducted on January 2018 at the Laboratory of Animal Feed and Nutrition, Faculty of Animal and Agricultural Sciences, Diponegoro University, Semarang The materials used in the study were: a) ration consisting of Supan-supan (*Neptunia plena* L. Benth) and Kolomento (*Leersia hexandra* Swartz), other feedstuffs (bran, palm oil cake and calliandra); b) in vitro material using: goat rumen fluid taken from Boestaman Semarang Slaughterhouse, Mc Dougall solution (artificial saliva), pepsin-HCL solution as protein degrading enzyme, ice water to stop the fermentation process, aquades, CO_2, indicator of metyl red and green bromycresol, saturated sodium carbonate (Na_2CO_3), boric acid solution, 0.5% HCl, phenolptalein 1% indicator, sulfuric acid 0.0055N, vaselin, sulfuric acid (H_2SO_4) 15% and 0.5 N NaOH and whatman filter paper 41.

Proximate Analysis

Feedstuffs as a composition for ration was analyzed by using proximate analysis (AOAC, 1990) to determine the nutrient content. This analysis classified component contained in the feedstock based on the chemical composition and the function. The fraction components analyzed were moisture content (MC), ash, crude protein (CP), eter extract (EE), crude fiber (CF) and material extract without nitrogen (NFE). The proximate analysis result of the feedstuffs shown in Table 1.

Table 1. Nutrient Content of Feedstuff

Feedstuffs	Nutrient Content (%)							
	MC	DM	Ash	OM	EE	CF	CP	NFE
Corn	10.03	89.97	0.77	99.23	1.68	0.38	8.14	89.13
Rice bran	11.09	88.91	5.49	94.51	5.97	24.75	9.97	53.82
Leersia hexandra Swartz	14.91	85.09	9.57	90.43	1.99	49.23	11.28	27.93
Neptunia plena (L.) Benth	13.11	86.89	4.82	95.18	3.20	54.76	15.49	21.73
Palm oil cake	7.73	92.27	1.37	98.63	9.57	48.78	14.03	15.17
Calliandra	6.46	93.54	11.35	88.65	2.23	55.84	23.86	6.72

Source: Proximate analysis results at the Animal Feed and Nutrition, Faculty of Animal and Agricultural Sciences, Diponegoro University, Semarang (2017).

Experimental Design

The experimental design used in the research was complete randomized design (CRD) with five treatments. The main consideration in ration projection followed the balance of crude protein (CP) content of 11%-12%, with the ration energy content calculated based on Total Digestible Nutrient (TDN) $\pm$60% in the fattening system. The balance limit of ration was in the range between the lowest limit of CP for ruminant i.e. 10% and the highest limit of CP for ruminant i.e. 14%, and the energy requirement (TDN) was$\pm$60%. The following is the percentage of feedstuffs and chemical composition of the treatment ration (Table 2):

Table 2. Percentage of feedstuffs and chemical composition of the treatment ration (% DM)

Composition	Treatment				
	T_1	T_2	T_3	T_4	T_5
	..................................(%)...............................				
Feedstuff:					
Leersia hexandra Swartz	100.00	-	15.00	20.00	25.00

Neptunia plena (L.) Benth	-	100.00	15.00	20.00	25.00
Maize	-	-	34.00	39.00	42.00
Rice barn	-	-	14.00	9.50	1.00
Palm oil cake	-	-	14.50	3.00	2.00
Calliandra	-	-	7.50	8.50	5.00
Total	100.00	100.00	100.00	100.00	100.00
Feed nutrient:					
DM	85.09	86.89	89.92	89.65	88.69
OM	90.43	95.18	94.30	94.27	94.42
CP	11.28	15.49	12.00	11.92	11.68
TDN*	40.88	38.38	60.00	59.80	59.39

Source: Proximate analysis result from Laboratory of Animal Nutrition Science, Faculty of Animal Husbandry and Agriculture, Diponegoro University, Semarang (2017).
*Calculation result according to Sutardi(2001).

In vitro Analysis

In vitro analysis to determine dry matter digestibility (DMD), and organic matter digestibility (OMD) was carried out using the method of Tilley and Terry (1963) (Mayulu et al., 2018). This method has two stages i.e. digested using rument liquid buffer for 48 hours and digested by using pepsin-HCL liquid for 48 hours (Tilley and Terry, 1963). The fermentation kinetic of N-NH_3, determined by the Conway Microdifusion technique and the fermentation of volatile fatty acid (VFA) using the Steam Destilation method (Riswandi et al., 2017).

1. Equation for DMD:

$$\text{DM Digestibility} = \frac{\text{DM weight of sample} - (\text{DM residue - blanks})}{\text{DM weight of sample}} \times 100\% \quad \text{.............................(1)}$$

2. Equation for OMD:

$$\text{OM Digestibility} = \frac{\text{OM weight of sample} - (\text{OM residue} - \text{blanks})}{\text{OM weight of sample}} \times 100\% \quad \text{..............................(2)}$$

Remarks:

DM sample = sample weight x % DM
DM residual = weight after oven-CP-filter paper
Blanks = weight after oven-CP-filter paper
OM sample = DM weight of sample x % OM
% OM = 100% DM - (% Ash content in DM)
OM residue = weight after oven - weight after tanur-filter paper

3. Equation for N-NH_3 Production:

N-NH_3 Production (mM)= ml titran H_2SO_4 x N H_2SO_4 x1000 ....(3)

Remark: N= Solution normality of H_2SO_4

4. Equation for VFA:

VFA Production (mM) = (a–b) x N HCl x 1000/5...(4)

Remarks:

a = Blanks Titran Volume (ml)
b = Sample Titran Volume (ml)

3. DATA ANALYSIS

Data generated from in vitro test were analyzed using Costat program for variance analysis (ANOVA) at 95% significance level followed by a Duncan Multiple Range Test (DMRT) test if there were difference between treatments.

4. RESULT AND DISCUSSION

1. Dry Matter and Organic Matter Digestibility

Feed digestibility is an important indicator as it can be used as a guide to determine the nutrient amount of feeds that can be absorbed by digestive tract. Low digestibility value indicates that the feedstuffs have less ability to supply nutrient for maintenance and production needs. Digestibility of feedstuffs be measuring effort to determine the nutrient amount contained in a feedstuff which will be degraded and digested in gastrointestinal tract (Mayulu, 2014). Tilley and Terry's in vitro method is commonly used method to evaluate feed's nutrient intake of ruminant and proven to be more accurate to assess digestibility (Mabjeesh et al., 2000). The average digestibility of dry and organic feedstuffs of goat ration (Table 3):

Table 3. Average digestibility of dry and organic feedstuffs of goat rations

Parameter	Treatment				
	T_1	T_2	T_3	T_4	T_5
	----------(%)----------				
DMD	$21.14^c \pm 2.16$	$30.93^b \pm 0.65$	$40.13^a \pm 1.24$	$37.79^a \pm 1.25$	$37.43^a \pm 0.57$
OMD	$31.42^d \pm 0.71$	$38.07^c \pm 0.54$	$46.63^a \pm 0.80$	$43.81^b \pm 0.85$	$44.01^b \pm 0.73$

Remark: Different superscribs at same row show significant different (P<0.05) T_1 (*Leersia hexandra* 100 %); T_2 (*Neptunia plena* 100%); T_3 (*Leersia hexandra* 15% + (*Neptunia plena* 15% + 70 % Other Feedstuffs); T_4 (*Leersia hexandra* 20% + (*Neptunia plena* 20% + 60% Other Feedstuffs); T_5 (*Leersia hexandra* 25% + (*Neptunia plena* 25% + 50% Other Feedstuffs).

Duncan Multiple Range Test results showed that the highest DMD was produced by T_3, but it wasn't significantly different from T_4 and T_5. T_3 treatment was significantly higher (P <0.05) compared to T_2 and T_1. The utilization of local feed in ration with the percentage of 15, 20, 25, based on the results of the study showed that DMD of T_3 (40.13%), T_4 (37.79 %) and T_5 (37.43%) respectively. Those value were better when compared to the utilization of single feed T_1 (100% *Leersia hexandra* Swartz) and T_2 (100% *Neptunia plena* L. Benth) with value of 21.14% and 30.93% respectively (Table 3). This shows that in terms of quantity of rations which are composed of local feed can contribute to the production of goats. The insignificant difference is probably caused by the nutrients contained in each feed compiler, but the yield of DMD in the study is lower when compared to research conducted by Riswandi et al. (2017) in the in vitro digestibility of fermented *Hymenacne acutigluma*-based rations supplemented with legumes obtained DMD as high as 65.88% and as low as 57.59%.

The low digestibility value is thought to be caused by the different chemical composition of the ration. The level of digestibility of feed determines the activity of rumen microorganisms, this is caused by microbial activity influenced by nutrients contained in feedstuffs (Mayulu et al., 2018). High percentage digestion of ration is an indication of the good quality of ration. Goat can digests low quality feed better than others ruminants. Factors that influence digestibility in terms of feed are type, amount, composition of feed, and treatment of feed (how to give, store and process) (Suardin et al., 2014). Dry matter is needed by livestock as a stomach filler, stimulating the walls of the digestive tract and strengthening the formation of enzymes in the body. The ability of livestock to consume DM is closely related to the physical capacity of the stomach, and the condition of the digestive tract (Umela and Bulontio, 2016).

The organic matter digestibility is closely related to DMD, because some DM are BO (CF, EE, CP, and NFE). Sufficient consumption of DM by livestock has an impact on fulfilling the need for OM which serves as an energy source for building substances in supporting metabolic processes in the body (Mayulu, 2015). The percentage of the amount of BO in the ration that can be digested by the digestive tract and subsequently will be utilized by the livestock body and rumen microorganisms to produce energy or VFA (Mayulu, 2015).

The average OMD ration of goats based on local feed in vitro (Table 3). Duncan Multiple Range Test results showed that the highest OMD was produced by T_3 (46.63%). T_3 treatment was significantly higher (P <0.05) compared to T_5, T_4, T_2, and T_5. Organic Matter Digestibility value this result was lower by Riswandi et al. (2017) in the in vitro digestibility of fermented *Hymenacne acutigluma*-based rations supplemented with legumes obtained OMD as high as 65.34% and as low as 53.48%. The low OMD value is thought to be caused by the different composition of feedstuffs and chemical composition of the ration.

2. **Rumen Fermentation Kinetic**

Volatile Fatty Acid is the product of the fermentation process by rumen microbes and acts as an energy source for livestock.

Table 4. Means of N-NH_3 and VFA Production feedstuffs of goat rations

Parameter	Treatment				
	T_1	T_2	T_3	T_4	T_5
	---(mM)--				
N-NH_3	4.43^{cd} ± 0.41	8.18^{a} ± 1.34	6.85^{ab} ± 0.56	6.04^{bc} ± 0.94	4.00^{d} ± 2.00
VFA	26.74^{c} ± 1.63	26.05^{c} ± 4.31	28.16^{bc} ± 6.11	37.25^{b} ± 8.90	50.21^{a} ± 6.71

Remark: Different superscrib shows significant difference (P<0,05), T_1 =100% *Leersia hexandra*; T_2 =100 % *Neptunia plena;* T_3=Ration (15% *Neptunia plena*+15% *Leersia hexandra*+70% other feedstuffs); T_4=Ration (20% *Neptunia plena*+20% *Leersia hexandra*+60% other feedtocks); T_5=Ration (25% *Neptunia plena*+25% *Leersia hexandra*+50% other feedstuffs

Rumen microbe can use about 80% ammonia as a source of nitrogen for growth (Arora, 1995) even the addition of amino acid and peptide can also improve the digestibility of fiber feed (Mayulu, 2014). The excessive amount of NH_3 in the rumen will be absorbed by the body of the animal and excreted in the form of urine and urea (Chanjula and Ngampongsai, 2008). If the rumen ammonia concentration is low, it inhibits the activity of rumen bacteria and results in decreased feed degradation (Harahap et al., 2017). Different N-NH_3 production can be caused by crude protein content in different treatments, as the amount of protein in ration can be influenced NH_3 production (Hidayah et al., 2014). Feed protein in the rumen will be hydrolyzed by proteolytic enzymes rumen microbes to produce oligopeptides which then undergo further digestion into peptide, some pass rumen degradation and some are hydrolyzed into amino acid (Trisnadewi *et al.,* 2014; Sandi et al., 2015).

The average N-NH_3 ration of goats based on local feed in vitro (Table 4). Duncan Multiple Range Test results showed that the highest N-NH_3 production was produced by T_2 (8.18 mM), but it wasn't significantly different from T_3 (6.85 mM). T_2 treatment showed significantly higher results (P <0.05) compared to T_4, T_1 and T_5. The high production of N-NH_3 at T_2 because T_2 is an arrangement with a legume composition of 100% Supan-supan.

Legumes can be a source of CP so it can increase N-NH_3 production and provide branched-chain amino acids as a source of carbon in the growth of fiber-digesting (cellulolytic) bacteria (Riswandi et al., 2017). Different N-NH_3 production is caused by the CP content in the treatment, because the amount of CP in the ration influences the production of N-NH_3. This is consistent with the opinion of Riswandi et al. (2017) The high and low concentrations of ammonia are determined by the level of protein in the ration, the length of stay in the rumen, rumen pH and the degree of degradability. The average concentration of N-NH_3 in the research ranged from 4.00 to 8.18 mM. These results indicate that the ration is able to support biosynthesis of rumen microbes, because the maximum level of N-NH_3 needed to support rumen microbial biosynthesis are 3.57-7.14 mM (Sunarso, 2003). Microbes can optimal work on the rumen fluid concentration 5 mg/100 ml (Mayulu, 2013). Rumen microorganisms cannot reproduce if the supply of N in the rumen is limited (Arora, 1995), as NH_3 is the primary N source of most ruminal rumen microorganisms (Chathurika et al., 2019). Availability of N-NH_3 is the most important determinant of microbial protein production because the majority of rumen bacteria use N-NH_3 as a nitrogen source, so it is important to determine N-NH_3 concentration that support microbial growth by utilizing NPN (Phesatcha and Wanapat, 2016).

The average VFA ration of goats based on local feed in vitro (Table 4). Duncan Multiple Range Test results showed that the production of VFA from T_5 (50.21 mM) was significantly higher ($P < 0.05$) compared to T_4, T_3, T_1, and T_2. The average concentration of VFA in this research ranged from 26.05-50.21 mM. These results are still below the VFA value for optimal microbial growth which ranges between 80-160 mM and the value is influenced by the type of feed given. Volatile Fatty Acid concentration is influenced by basal feed, type of feed's carbohydrate, physical form of feed, consumption level, frequency of feed, and use of chemical additives. Higher VFA concentration indicates increased rumen microbial activity because more organic material is fermented in the rumen (Madrid et al., 2002). The formation of VFA in the rumen is very important because 70-85% of ruminant energy comes from VFA (Marriot, 2010; Trisnadewi et al., 2014)

Ration quality testing based on DMD data, OMD in T_3 can be followed by direct analysis (in vivo) for completeness of feed digestibility studies in order to get a better level of accuracy as well as combining rations with different formulations that make the digestibility of local feedstuffs has hight digestibility to meet the needs of goat and ruminant in general.

5. CONCLUSION

Based on the result of the research and through variance analysis assessment, evaluation of in vitro digestibility and fermentation level of goat's local feed-based ration can be concluded as use of local feedstuffs by quantity can contribute to the production of goats.

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