Ratio Effects of Dietary Energy and Protein using Local Feed on *in situ* Rumen Degradation Kinetics of Ongole Crossbreed

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ABSTRACT
The present study investigated the ratio effects of dietary energy and protein on *in situ* rumen degradation kinetics of Ongole Crossbreed. Local feed consisting of dried cassava as energy source and palm kernel as protein source were used in the present study. Two dietary ratios of dried cassava and palm kernel were prepared, 8:2 ratio (T1) and 1:1 ratio (T2). Each dietary treatment (5 g) in quadruplicate were placed into nylon bag, and then incubated into cannulated rumen for 4, 8, 16, 24, 48, 72, and 96 h. At the assigned hour, samples were collected from cannulated for laboratory analysis. In results, the degradation of dry matter and organic matter were higher ($P<0.05$) in dietary T1 than in dietary T2. Also, rumen degradation kinetics consisting of the immediately degradable fraction, the potentially degradable fraction, fractional degradation rate, and theoretical degradability were higher ($P<0.05$) in dietary T1 than in dietary T2. Even though contain higher crude protein, dietary T2 had numerically lower nitrogen-free extract and higher crude fiber that caused low in situ rumen digestibility. In conclusion, dietary T1 is recommended to apply for Ongole Crossbreed in the field scale.

Keywords: *Dried cassava, Dietary ratio, In situ, Palm kernel, Rice straw,*

1. INTRODUCTION

In general, agricultural by-products have been applied to supply the requirement of animal feed, one of commonly used is rice straw. Rice straw is the main source of roughage that fed into the ruminants by many farmers in Indonesia. As a local feed, rice straw is cheap and available during the year. However, it contains low soluble carbohydrate and protein sources to supply the requirement of ruminants. Thus, the addition of feedstuffs containing energy and protein sources, respectively, are necessary when animals are fed a rice straw in the field.

As an agricultural rich-resources country, Indonesia also produces several local feedstuffs resulted from food industry waste. Dried cassava and palm kernel are examples that are available and abundant in many areas of Indonesia. Either dried cassava or palm kernel have been commonly used as energy or protein sources for ruminant diet, respectively. It could be indicated that dried cassava presented low crude fiber (CF) at 2.93-3.91% and crude protein (CP) at 1.86-3.84% [1]. Moreover, dried cassava contained 1100-1490 kcal energy per kg with 17 g of total sugars [2]. Dried cassava is easy to degrade in the rumen and produces a high concentration of volatile fatty acid due to containing a high energy level [3]. On the other side, palm kernel had CP at 20% and CF at 13% [4], which is a good protein source for ruminants with low prices.

The information of nutrient balance among energy and protein for cattle is important to maintain their performance, especially considering the use of local feed

for animal diet. Ongole Crossbreed is the local cattle that develop by almost all the farmers in Indonesia. Different cattle breeds could present different results in growth performance, including their ability to digest feedstuff [5]. The study of local feed for Ongole Crossbreed is necessary to improve the livestock industry in the future since the Ongole Crossbreed is the most potential local breed for meat production in Indonesia. In addition, the use of local feeds, such as dried cassava and palm kernel, as animal diet should be considered in the measurement of nutrient balance among energy and protein sources. Therefore, the purpose of the present study is to investigate the ratio effect of dietary energy and protein sources using local feed on ruminal degradation kinetic of Ongole Crossbreed by *in situ* technique.

2. MATERIALS AND METHODS

2.1. In situ incubation

The present study was conducted by *in situ* technique using two cannulated steers of Ongole crossbreeds (45 mo). Animals were fed with a standard diet consisted of rice straw and concentrate at 8:2 ratio plus vitamin-mineral premix. Concentrate for animals consisted of dried cassava and palm kernel, which the application of ratio followed the dietary treatments. Animals fed a standard diet at 08.00 and 16.00 with free water access. Dietary treatment in the present study used a different proportion of dried cassava and palm kernel following: 8:2 ratio (T1) and 1:1 ratio (T2). Five grams of dietary treatments were placed into a nylon bag with 46 μL of diameter pores. In each steer, both T1 and T2 were applied in quadruplicate and incubated in cannulated steer for 4, 8, 16, 24, 48, 72, and 96 h along with Pangola grass as standard. Pangola was also incubated in quadruplicate as blanks. At the assigned hour, dietary treatment was collected from cannulated steer and stored for laboratory analysis.

2.2.Chemical composition

Before and after ruminal incubation, dietary treatments were sub-sampled at 100 g and dried at 55ºC for 48 h. Samples were ground to pass 1 mm screen using a cutting meal for determination of chemical compositions. Dry matter (DM) of dietary treatment was determined by drying 10 g of sample into a forced-draft oven at 105ºC for 24 h (method 934.01). Organic matter (OM) was determined with a muffle furnace at 550ºC for 5 h (method 942.05). The CP and ether extract (EE) were determined by the producers of Kjeldahl (method 984.13) using N analyzer and Soxhlet (method 920.39), respectively. The CF was analyzed by boiled sample in acid and basal solution (method 987.10). All protocols to analyze chemical compositions followed AOAC [6].

2.3. Rumen degradation kinetic

Rumen degradation kinetics of DM and OM were calculated using the exponential equation by Ørskov and McDonald [7] following:

$$Y = a + b\,(1 - e^{-c\,(t-L)}) \text{ for } t > L \quad (1)$$

where a is the immediately degradable fraction; b is the potentially degradable fraction; c is fractional degradation rate; L is lag phase; and t is the time of incubation (h).

The value of a, b, and c were used to calculate theoretical degradability (TD) using the model of Verite and Peyraud [8] following:

$$TD = a + \{(b \times c)/(c + Kp)\} \quad (2)$$

The fractional passage rate (Kp) was assumed by 0.05 in the present study.

2.4. Statistical analysis

All collected data were analyzed as one way ANOVA using the procedure of Software Statistical Product and Service Solution (SPSS, version 16). Mean separation was performed by Tukey's test, and the significant differences were declared at $P<0.05$.

3. RESULTS AND DISCUSSION

The chemical compositions of the diet that used in the present study were presented in Table 1. In general, rice straw as roughage source contained CF at 33.3%. As an energy source, the CP, CF, and nitrogen-free extract (NFE) of dried cassava were 2.03, 3.63, and 89.6%. As a protein source, the CP, CF, and NFE of palm kernel were 16.2, 22.7, and 44.8%. With the lower ratio of protein source, T1 numerically had higher NFE with lower CP, TDN, and metabolized energy (ME) than T2.

Degradation of DM and OM during *in situ* ruminal incubation were presented in Figure 1. The present study reported that dietary T1 had higher ($P<0.05$) degradation of DM and OM during ruminal incubation compared to dietary T2. Supporting these results of DM and OM degradations, the ruminal degradation kinetics of DM and OM in Table 2 also showed a similar result. The immediately degradable fraction, the potentially degradable fraction, factional degradation rate, and TD in both degradations of DM and OM were higher ($P < 0.05$) in dietary T1 than dietary T2. These results indicated that a higher ratio of dried cassava as an energy source presented higher digestibility in the rumen.

Table 1. Chemical compositions of feedstuff and diet in the present study (%, DM)

Item	Feedstuff/diet[2]				
	Rice straw	Dried cassava	Palm kernel	T1	T2
DM	84.4	85.1	90.8	89.4	90.5
OM	76.7	97.3	95.5	97.4	96.8
CP	6.29	2.03	16.2	4.29	8.32
CF	33.3	3.63	22.7	6.37	11.3
EE	1.33	2.00	11.9	0.57	3.19
NFE*	35.7	89.6	44.8	89.2	74.0
TDN*	39.3	75.3	31.2	80.9	70.5
ME*	2.20	12.2	3.92	3.15	2.69

[1]DM, dry matter; OM, organic matter; CP, crude protein; CF, crude fiber; EE, ether extract; NFE, nitrogen-free extract; TDN, total digestible nutrient; ME, metabolizable energy.
[2]T1, dietary ratio of dried cassava and palm kernel at 8:2; T2, dietary ratio of dried cassava and palm kernel at 1:1.
*Estimated using formulation of Hartadi et al. [9].

According to a previous study, a high concentration of non-structural carbohydrates in the diet was reported to increase digestibility in the rumen [10]. Dried cassava contains low CF and high NFE (Table 1), which could be easily degraded by rumen microbes [11]. The high ratio of dried cassava increase the concentration of non-structural carbohydrates in the diet. This case was the reason for the high ruminal degradation of dietary T1 in the present study.

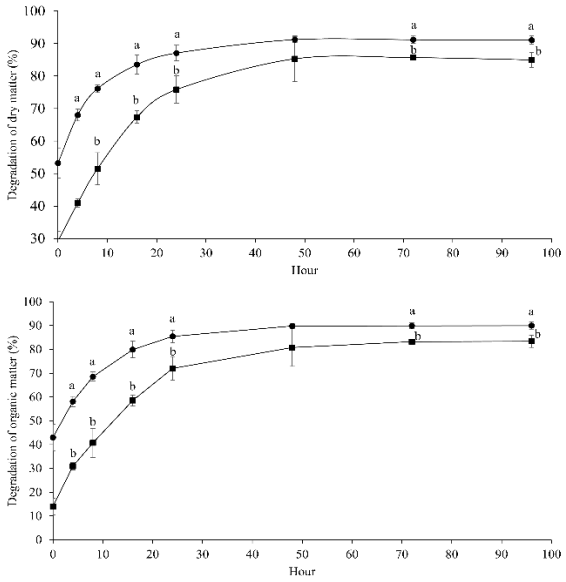

Fig. 1. Degradations of dry matter and organic matter during *in situ* ruminal incubation by dietary with different ratio of energy and protein sources. T1, dietary ratio of dried cassava and palm kernel at 8:2 (●); T2, dietary ratio of dried cassava and palm kernel at 1:1 (■). Error bar represent standard deviation. [a,b]Means in same hour with different superscripts differ significantly (P<0.05).

Table 2. Ratio effects of dietary energy and protein sources on *in situ* ruminal incubation of Ongole Crossbreed during 96 h

Item[1]	Dietary treatment[2]	
	T1	T2
Dry matter		
a, %	53.9[a] ± 4.02	32.7[b] ± 2.31
b, %	36.8[a] ± 3.60	54.2[b] ± 1.57
c, %/h	0.12[a] ± 0.29	0.06[b] ± 0.00
TD, %	79.7[a] ± 1.05	62.0[b] ± 1.71
Organic matter		
a, %	44.2[a] ± 4.63	18.3[b] ± 2.79
b, %	46.3[a] ± 4.08	67.6[b] ± 1.89
c, %/h	0.10[a] ± 0.02	0.06[b] ± 0.01
TD, %	74.6[a] ± 1.30	54.3[b] ± 2.05

[1]a, the immediately degradable fraction; b, the potentially degradable fraction; c, fractional degradation rate; TD, theoretical degradability.
[2]T1, dietary ratio of dried cassava and palm kernel at 8:2; T2, dietary ratio of dried cassava and palm kernel at 1:1.
[a,b]Mean in the same row with different superscripts differ significantly (P<0.05).

On the other side, dietary with a higher ration of palm kernel was presented lower digestibility in the rumen even though presented higher CP concentration. It could be caused due to the high concentration of CF in the diet (Table 1). Dietary T2 almost presented two times higher of CF concentration, which could be a limiting factor of digestibility in the rumen [11]. In addition, dietary T2 presented lower NFE and TDN than dietary T1, which could be the other reason for low ruminal digestibility [11].

4. CONCLUSION

The present study concluded that dietary local feed with T1 as 8:2 ratio of energy and protein is recommended to improve *in situ* ruminal digestibility of Ongole Crossbreed.

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