The Proportion of Cassava and Palm Kernel Cake Affects *in situ* Rumen Degradation Kinetics in Ongole Crossbreed

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ABSTRACT
The present study investigated the effect of varying the proportion of dried cassava and palm kernel cake on *in situ* rumen degradation kinetics in Ongole Crossbreed. Ongoles were fed two different concentrate rations of cassava and palm kernel cake (PKC) varying in percentage with one concentrate mixture comprising 80% cassava with 20% PKC and the other concentrate mixture was 50% cassava mixed with 50% PKC. Each concentrate mixture was fed with rice straw to make a total mixed ration of approximately 80% rice straw and 20% concentrate. Each ration was fed to one of two rumen fistulated cattle in a cross-over design. Each period was of two weeks with an adaptation period. *In situ* degradation was measured in the second week. A sample of the mixed concentrate was measured into each nylon bag such that the proportion of cassava or PKC was the same as the ration concentrate being fed ie 80:20 or 50:50 cassava:PKC respectively. Each mixed concentrate treatment (5 g) was weighed in quadruplicate into nylon bags and then incubated in the rumen for 4, 8, 16, 24, 48, 72, and 96 h, removed at these times, dried and analysed for DM and organic matter. The degradation kinetics of dry matter and organic matter were higher ($P<0.05$) in the 80:20 concentrate treatment than the 50:50 concentrate treatment. The immediately degradable fraction, the potentially degradable fraction, fractional degradation rate, and theoretical degradability were higher ($P<0.05$) in the 80:20 concentrate treatment thanthe 50:50 dietary treatment even though this had a higher crude protein content. In conclusion, degradation rate of the 80:20 cassava concentrate was higher and reflected the higher starch content of this mixed ration. It would be the better concentrate mixture as a supplement but if fed at high levels the 50:50 concentrate mixture would be a safer option to avoid acidosis.

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

1. INTRODUCTION

Rice straw is the main source of roughage fed to ruminants by many farmers in Indonesia. As a local feed, rice straw is cheap and available during the year. However, it is low in digestibility and crude protein content and supplements are commonly fed.

As an agricultural rich-resources country, Indonesia also produces several local feedstuffs as crop by-products or processing by-products. Dried cassava and palm kernel cake (PKC) are examples that are available and abundant in many areas of Indonesia. Cassava is high in digestibility but low in crude fiber (CF, 2.93-3.91%) and crude protein (CP, 1.86-3.84%) [1]. Dried cassava is easy to degrade in the rumen and produces a high concentration of volatile fatty acid [3]. PKC has a CP of 20% and CF of 13% [4], which is a good protein source for ruminants at a low cost.

Cassava and PKC can be fed in various combinations to form a concentrate or a supplement to Ongole cattle. A

high level of cassava (>50%) when fed at high quantities per day has led to a depression in feed intake possibly due to acidosis [12]. It is also high in starch whereas PKC has a higher fibre content. Thus it is important to determine the effect of different proportions of cassava and PKC on rate of digestion of the mixed concentrate.

2. MATERIALS AND METHODS

2.1. In situ incubation

The present study was conducted by *in situ* technique using two cannulated Ongole crossbreed steers (45 months) in a cross-over design with two animals and two concentrate mixtures with nylon bag treatments. Animals were fed a standard diet consisting of rice straw and concentrate mixture at 8:2 ratio plus vitamin-mineral premix. Concentrate mixture for animals consisted of dried cassava and PKC in different proportions depending on the dietary treatment. One concentrate mixture treatment was a mixture of 80% cassava and 20% PKC and the other concentrate treatment was a mixture of 50% cassava and 50% PKC. Animals were fed at 08.00 and 16.00 with free access to water. To examine the rate of digestion of these concentrate mixes five grams of each concentrate mixture were placed into nylon bags with 46 μ diameter pores. In each steer, the same concentrate mix was incubated as the concentrate mixture diet the animal received and then this was reversed as per cross-over for the second period. Bags were prepared in quadruplicate and incubated in cannulated steers for 4, 8, 16, 24, 48, 72, and 96 h along with Pangola grass as a standard. Pangola was also incubated in quadruplicate. At the assigned hour, nylon bags were sampled from the rumen and stored for laboratory analysis.

2.2.Chemical composition

Feed samples were sub-sampled (100 g) before and after each treatment period and dried at 55ºC for 48 h. Samples were ground to pass 1 mm screen using a cutting meal for determination of chemical composition. 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 to be 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 composition of the ingredients and concentrate mixtures were presented in Table 1. In general, rice straw had a high CF at 33.3%. The CP, CF, and nitrogen-free extract (NFE) of dried cassava were 2.03, 3.63, and 89.6%. The CP, CF, and NFE of PKC were 16.2, 22.7, and 44.8%. The 80:20 mixture of cassava:PKC was lower in CP but higher in NFE, TDN and estimated ME than the 50:50 mixture.

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

Item	Feedstuff/diet[2]				
	Rice straw	Dried cassava	Palm kernel	Mix 80:20	Mix 50:50
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.
Mix of dried cassava and palm kernel cake at 80:20 or 50:50
*Estimated using formulation of Hartadi et al. [9].

Degradation rate of DM and OM of the 80:20 concentrate mixture was higher (P<0.05) than the 50:50 concentrate mix (Figure 1). The ruminal degradation kinetics of DM and OM in Table 2 also showed a similar result. The immediately degradable fraction, the potentially degradable fraction, fractional degradation rate and TD for both DM and OM were higher (P < 0.05) in the 80:20 concentrate mixture compared to the 50:50 concentrate mixture.. These results indicated that a higher ratio of dried cassava as an energy source resulted in a higher digestibility and rate of digestion in the rumen. 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 and starch (Table 1), which could be easily degraded by rumen microbes [11]. The high ratio of dried cassava increased the concentration of non-structural carbohydrates in the diet. This rapid digestion of the 80:20 concentrate mix suggests that, when feeding this supplement at a high level, care needs to be taken to slow the rate of intake by feeding at least twice a day and smaller amounts. The high rate of digestion may account for the depression in intake seen with high levels of this concentrate mix in other studies [12].

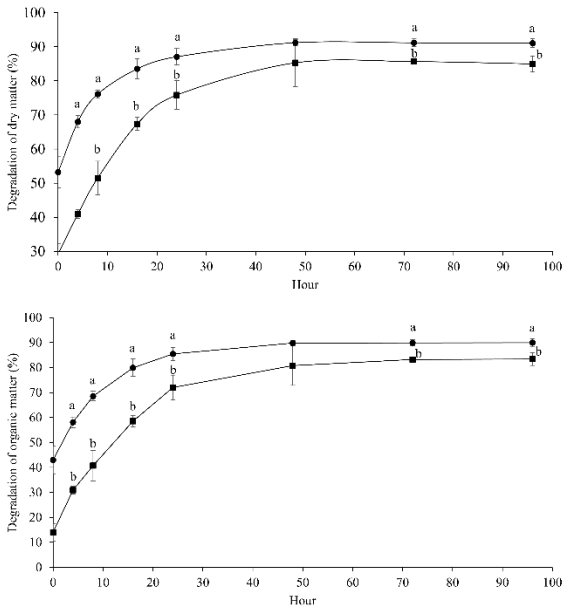

Fig. 1. Degradations of dry matter and organic matter during *in situ* ruminal incubation by dietary with different ratio of energy and protein sources. The two concentrate mixtures were dried cassava and palm kernel at 80:20 (●) and 50:50 (■). Error bar represent standard deviation. [a,b]Means in same 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 over 96 h

Item[1]	Dietary treatment[2]	
	Mix 80:20	Mix 50:50
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.
Concentrate mix of dried cassava and palm kernel cake at 80:20 or 50:50
[a,b]Mean in the same row with different superscripts differ significantly (P<0.05).

The 50:50 concentrate mix had a slower rate of digestion (about half) and may be considered a safer combination to feed to animals. It had a much higher CF and CP content which would affect the rate and extent of digestion [11]. The higher CP content would be beneficial when supplementing rice straw.

4. CONCLUSION

It may be concluded that the 80:20 concentrate mix had a higher rumen digestion and rate of digestion and so would supply more nutrients to the animal. However if it was fed at a very high level then the rate and extent of digestion may be too high and lead to acidosis. The 80:20 concentrate mixture would better as a supplement but the 50:50 concentrate mixture would be better if the concentrate mixture was fed at a very high level.

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