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Short Communication

Effect of Palm Oil By products on *In Vitro* Fermentation and Nutrient Digestibility

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ABSTRACT

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Indonesia has the most abundant palm oil by products such as oil palm fronds (OPF), palm oil sludge (POS) and palm kernel cake (PKC) that can be used as feed for ruminant. The aim of this experiment was to study the level of OPF, POS, PKC on *in vitro* digestibility and fermentation. Oil palm fronds was previously treated with 3% urea. The five treatments consisted of native grass as control and four levels of palm oil by products viz., A= native grass (control), B= 30% OPF + 50% POS + 20% PKC, C= 40% OPF + 40% POS + 20% PKC, D= 50% OPF+ 30% POS+ 20% PKC, and E= 60% OPF + 30% POS + 20% PKC. The formulated feeds were evaluated adopting Tilley and Terry method. The results indicated that increasing use OPF in diet caused lowered ammonia-N and total volatile fatty acids concentration in the incubation medium. There was a reduction ($P<0.05$) in the *in vitro* DM digestibility in all the OPF containing diet vis-à-vis the control. Digestibility of CP was also reduced ($P<0.05$) in diets C and D as compared to A; that of diet E was of the lowest. The digestibility all nutrients showed a gradual decline with increasing proportion of OPF in the formulation. It is concluded that use of OPF based oil palm by products reduced *in vitro* digestibility. Further animal trials are needed to confirm the optimal level of its use.

Key words: Ammoniation, Degradability, Fermentation, Oil palm fronds, Palm oil by product.

INTRODUCTION

The low productivity of ruminant livestock in Indonesia could be due to low quality available feedstuff. Oil-palm by product can be used as ruminant feed to support the ruminant industry. There are several by products of oil-palm such as oil palm fronds (OPF), palm kernel cake (PKC), palm oil sludge (POS) all having potential to be used as ruminant feed (Elizabeth and Ginting, 2003).

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Oshio *et al.*, (1990) reported that OPF has the potential to be used as a source of fiber feed or as a component of a complete ration for ruminants. Oil palm frond availability in Indonesia is quite a lot to support a large ruminant population because Indonesia has the vast area under oil palm plantation. According to Direktorat Jenderal Perkebunan of Indonesia (2008), oil palm plantation area in Indonesia reached 4.686.000 ha, with ages varying from 1 to 25 years, yields 6 tons of oil palm frond/ month/ha or yielding 72 tons/year/ha. Total DM OPF produced in a year for each hectare is 5.214 kg of 20 tons of fresh OPF (Diwyanto *et al.*, 2004). Based on the content of fiber fractions such as NDF (78.7%) and ADF (55.6%), the OPF is a suitable feedstuff for ruminants (Alimon and Bejo, 1995). However, large scale use OPF in animal feed is still limited because of its high lignin and low CP content, besides lower digestibility. Improvement in the quality of agricultural or agro-forestry by product for animal feeding can be done through various processing methods involving physical, chemical, and biological treatments or even combination of these treatments. Efforts have been made to improve the quality and digestibility of OPF through used ammoniation process. Several researchers have studied the effects of OPF silage on fermentation characteristics, palatability and effect on animal performance (Abu Hassan and Ishida, 1991; Ishida and Abu Hassan, 1997; Oshio *et al*, 1999).

Palm kernel cake is the result of processing of palm kernel. In general, PKC has moisture ≤10%, protein 14-17%, fat 9.5-10.5%, and crude fiber 12-18%. With such a nutrient composition, PKC has a potential as feedstuff for ruminants and non-ruminant. In Indonesia, the availability of PKC is 2-3 million tons, which makes it an important animal feed resource (Iskandar *et al.*, 2008)

Palm oil sludge is the result of the extraction of palm oil (Devendra *et al.*, 1981). In oil palm plantation, the POS is used as a fertilizer and soil cover, while its utilization in animal feed is limited (Chavalparit *et al.*, 2006; Paepatung *et al.*, 2009). Palm oil sludge has considerable potential as animal feed with typical chemical composition of DM 81.56%, CP 12.63%, crude fiber 9.98%, crude fat 7.12%, calcium 0.03% and phosphorus 0.003%. Utilization of POS as a feed can also beneficial through reduced pollution. Bamikole and Ikatua (2009) reported that POS has considerable potential as ruminant feed as an energy source. The present study was conducted to evaluate the effect of different combination of the three palm oil by products on the *in vitro* fermentation and degradability in rumen.

MATERIALS AND METHODS

This research was conducted in the Ruminant Nutrition Laboratory, Faculty of Animal Science Andalas University during March to June 2012. The experiment was arranged in a Completely Randomized Design consisting of five treatments, each with three replication. The treatment diets consisted of native grass as control (A), and four combinations of palm oil by products viz., 30% OPF + 50% POS + 20%

PKC (B), 40% OPF + 40% POS + 20% PKC (C), 50% OPF+ 30% POS+ 20% PKC (D) and 60% OPF + 30% POS + 20% PKC (E). Each of the treatment diets has a fixed (20%) proportion of PKC and OPF used was previously treated with 3% urea (Ishida and Abu Hassan, 1992). The chemical composition of basal feed stuff is shown in Table 1.

The fermentability and degradability of nutrients was determined using the first stage of Tilley and Terry (1963) procedure. Ruminal fluid was taken from a cannulated steer. Fermentation tubes contained of 0.5g samples and 40 ml of McDougall buffer solution and 10 ml of ruminal fluid and were incubated in 100 ml polyethylene tubes at 39°C for 48h in a water bath shaker. Treatments were replicated three times within an experiment and the experiment was repeated twice. The tubes that did not contain samples were also incubated and used as blanks.

After 48h, fermentation was terminated by injecting the tubes with 1 ml of $HgCl_2$. Tubes were the centrifuged at 14000 xg for 15 min and the supernatant was collected and stored. The residue was dried for 48h at 60°C and weighed and the data were used for degradability determination. These residues were also analyzed for their DM, OM, and nitrogen by using standardized procedures (AOAC, 1990). The NDF, ADF and cellulose of residues were determined as per method of Goering and Van Soest (1970). Supernatants were used to determine the total VFA concentration (by gas chromatography), rumen fluid pH and NH_3 concentration (microdiffusion Conway method).

Data were analyzed by ANOVA using the GLM procedure. Differences between the control treatment and level of palm oil by product were analyzed by the Duncan multiple range test (DMRT) (Steel and Torrie, 1980).

Table 1. Chemical composition of treatments diets (%)

Nutrients	Treatments†				
	A	B	C	D	E
CP	10.92	11.21	10.81	10.4	10,00
CF	30.60	23.48	25.56	27.63	31.55
EE	1.97	9.52	8.39	7.25	6.12
NDF	61.64	58.269	57.64	57.01	56.39
ADF	41.2	41.442	41.82	42.19	42.56
Cellulose	28.24	24.996	26.39	27.79	29.44
Hemicellulose	20.44	16.827	15.83	14.83	13.83
Lignin	7.80	13.594	14.04	14.48	14.92
TDN‡	60.00	60.24	59.23	58.22	57.20

Source: M. Zain, (2012).

†A= native grass (control), B= 30% OPF + 50% POS + 20% PKC, C= 40% OPF + 40% POS + 20% PKC, D= 50% OPF+ 30% POS+ 20% PKC, and E= 60% OPF + 30% POS + 20% PKC

‡TDN values were estimated based on Hartadi *et al*. (1997)

RESULTS AND DISCUSSION

The data on average digestibility and fermentation are presented in Table 2. The result showed that digestibility and fermentation of five treatments were significantly ($P<0.05$) different. Increased proportion of OPF in the diet caused lower digestibility and fermentation of nutrients in the rumen.

There was no significant difference ($P>0.05$) of oil palm by- product combination on ruminal fluid pH. The pH range observed in this study (Table 2) was within normal ranges (6.0-7.0) as reported optimal for microbial digestion of protein and fiber (Van Soest, 1994). In addition, Grant and Mertens (1992) reported that the optimal pH for microbial digestion of fiber is between 6.5-6.8, while Kopecny and Wallace (1982) reported that the optimal pH for microbial digestion of fiber ranged from 6.87 to 6.94.

The concentration of NH_3-N concentration in treatment E containing 60% OPF was significantly ($P<0.05$) lower than B, C and D that confirmed 30, 40 and 50% OPF, respectively. It could be due to low protein content of OPF, in spite of it being treated with ammonia. Further, when compared with control (A), the NH_3-N levels were significantly ($P<0.05$) reduced when oil palm by-product were used in the diet irrespective of combination. Nonetheless, ruminal NH_3-N levels could be considered as optimum for microbial protein synthesis. The optimal NH_3-N concentration in ruminal fluid for maximum microbial growth or microbial protein synthesis is reported to be in the range of 5-8 mg/dl (Satter and Slyter, 1974; Pisulewski *et al.*, 1981).

Table 2. Effect of various combination of oil-palm by- products in diet on *in vitro* fermentation and digestibility of nutrients

Parameters	Treatments					SEM
	A	B	C	D	E	
pH	6.89	6.88	6.88	6.94	6.87	0.06
VFA (mM)	106^{a}	92^{b}	90^{b}	82^{b}	67^{c}	0.79
NH3 (mg/dl)	18.83^{a}	15.16^{b}	14.59^{b}	13.80^{b}	12.60^{c}	1.02
In vitro digestibility (%)						
DM	76.71^{a}	72.78^{b}	63.93^{c}	61.11^{c}	55.32^{d}	1.27
OM	74.12^{a}	69.22^{a}	57.57^{b}	54.14^{b}	44.02^{c}	1.75
CP	77.09^{a}	73.49^{a}	65.057^{b}	63.89^{b}	57.91^{c}	0.85
NDF	51.63^{a}	49.42^{a}	41.19^{b}	40.34^{b}	37.68^{c}	0.50
ADF	50.02^{a}	46.55^{b}	40.19^{c}	39.79^{c}	34.94^{d}	0.92
Cellulose	54.41^{a}	42.78^{b}	40.60^{b}	38.57^{c}	35.08^{d}	0.97

Means in the same row with different superscript significantly ($P<0.05$)

A = native grass (control), B = 30% OPF + 50% POS + 20% PKC, C = 40% OPF + 40% POS + 20% PKC, D = 50% OPF+ 30% POS+ 20% PKC,and E= 60% OPF + 30% POS + 20% PKC.

The total VFA concentration in the rumen was significantly different ($P<0.05$) among treatments, following the same trend as NH_3-N. The VFA concentration showed a clear decreasing trend when the level of OPF in the diet was increased. High silica content and the slow rate of fermentation of fiber, could have been the cause for such a trend. The role of end products of fiber digestion in relation to the overall efficiency of energy was reported by Mertenz (2009); higher crude fiber, NDF, ADF and lignin content would decrease the digestibility and fermentation. The concentration of total VFA concentration in all treatments was higher than the normal concentrations of 70-130 mmol/l, the range suggested by France and Siddons (1993).

Digestibility of DM, OM, CP, NDF, ADF, and cellulose were significantly ($P<0.05$) different among the treatments. The increasing use of the OPF level in the diets decreased in nutrient digestibility. This could be related to the increased lignin content with higher levels of OPF incorporation that limit digestibility in ruminants. In addition, Mertenz (2009) reported that the high crude fiber, NDF, ADF and lignin content will decrease the digestibility. The same is also reported by Van Soest (1994) that lignin is one of the factors limiting microbial digestibly. The treatment containing 60% OPF tended to have lower nutrient digestibility than those of other treatments.

Results of the study showed that palm oil by product has the potential to be used as ruminant feed. Increasing levels of OPF had a negative impact on the *in vitro* nutritional attributes, although OPF levels up to 40-50% may be considered without adverse effects. However, further animals trials should be conducted to delineate optimum levels of its inclusion as ruminant feed.

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