Asian Jr. of Microbiol. Biotech. Env. Sc. Vol. 20 (October Suppl.) : 2018 : S36-S40

ISSN-0972-3005

ENHANCEMENT FERMENTED OLI PALM TRUNK ON RATION COMPLETE ON RUMEN DEGRADABILIY *IN VITRO*

YETTI MARLIDA[1], ARNIM[2] AND HARNENTIS[1]

[1]Department of Animal Nutrition and Feed Technology, Faculty of Animal Science, Andalas University, West Sumatera, Indonesia
[2]Department of Animal Production, Faculty of Animal Science, Andalas University, West Sumatera, Indonesia

(Received 28 February, 2018; accepted 30 April, 2018)

Key words : *Degradability, In vitro, Fiber fraction, Fermented*

Abstract – This study aimed to determine enhancement of fermented oil palm trunk on ration complete on rumen degradability in vitro. The experiment was conducted using a Randomized Block Design (RBD) consisted of 4 treatments and 4 replication. The treatment provided were A: 30% of fermented oil palm trunk plus 70% concentrates; B: 40% of fermented oil palm trunk plus 60% concentrates; C: 50% of fermented oil palm trunk plus 50% concentrates; D: 60% of fermented oil palm trunk plus 40% concentrates, and the measured variables were chemical composition and rumen degradability in vitro such as dry matter (DM), organic matter (OM) digestibility, rumen fluid characteristics (pH, NH3, and VFA) as well as fiber fraction digestibility (NDF, ADF, cellulose). The results showed that the treatment significantly affected ($P< 0.01$) on the DM, OM digestibility, fiber fraction digestibility (NDF, ADF, cellulose), NH3 and VFA and did not significantly affect ($P> 0.05$) on pH. The finding indicated that the use of 40% of fermented oil palm trunk plus 60% concentrates yields the best rumen degradability with the following characteristics:DM and OM degradability: 67.39%, and 67.52 %, ADF, NDF and cellulose degradability : 43.03%, 54.13%, and 58.26% for ADF, NDF and cellulose. The rumen characteristic were: 6.89, 18.49 (mg/100), 98.75 (mM) for pH, NH3 and VFA, repectively.

INTRODUCTION

The lack of adequate feed in Indonesia is a major concern for livestock farmers despite the large amount of various byproducts produced in developing countries. Palm oil and industrial oil palm waste are among the most important lignocellulosic compounds (Awalludin *et al.,* 2015). which contain larger quantities of such as oil palm trunk (OPT) and oil palm front (OPF) whereas the by-products are obtained from residues in the plantations. OPT is only available after oil palms are felled for replanting at an age of about 25 years. The biomass consists mainly of vascular bundles and parenchyma tissues. The nutritive value of OPT is similar to PPF and it contains about 3% CP. The vascular bundles contain less lignin than the parenchyma tissues and in digestibility studies with sheep; the parenchyma tissue had higher dry matter and organic matter values (Zahari *et al.,* 2009).

To improve usability of carbohydrates contained in parenchyma tissue, microorganisms of rumen should be provided with greater access to components of cell walls. OPT is not among the favorite nutrients easily accessible by livestock, processing can enhance their nutritional value and provide captive animals with suitable feed (Marlida *et al*., 2016). Low crude protein, high lignin and low palatability are the limiting factors of the OPT as animal feeding. The biological treatment such as fermentation is the technique is safer and cheaper than other, and fermentation using fungi more easily compared to an other microbes. Among these fungi are white rot fungi that belong to *Phanerochaete chrysosporium* and are highly capable of degradation and consuming lignin and cell wall compounds (Elisashvili and Kachlishvili, 2009). White rot fungi have also been shown to selectively degrade lignin (Van Kuijk *et al*., 2015; Sindhu *et al*., 2016).

To reach the target of Indonesia government it is necessary to create a local feed in the form of a

***Corresponding author's email**: yettimarlida@ansci.unand.ac.id

complete feed that is cheap and gives a high daily weight gain. The complete feed based on palm oil waste (fermented oil palm trunk) hopefully can be used as animal feeding more than 30% in the ration. The present study, therefore, attempts to examine effects improvement of fermented oil palm trunk on ration complete to chemical composition and rumen degradability.

MATERIALS AND METHODS

Preparation of oil palm trunk: Oil palm trunk (OPT) collected from field used as raw materials, it was ground and sieved to 18-20 mesh by shredding machine. The shredded oil palm trunk was dried at 60 ^{0}C in an oven for 12 h. The dried oil palm trunk (OPT) was kept ready for the further use.

Fermentation of oil palm trunk: Fermentation of oil palm trunk was performed using *Phanaroechaete crysporium* mold, which was fermented for 21 days with the addition of 0.03% urea in the fermentation medium. The proximate analysis of oil palm trunk and fermented oil palm trunk by AOAC (2000) and fiber fraction by Van Soest (1991).

Preparation of complete ration: Complete ration is composed of a combination of fermented oil palm trunk and concentrate, where with increasing fermented oil palm trunk, there will be a decrease in the use of concentrate in the ration. The composition of concentrates (Table 1.)

In vitro* digestibility assay:** *In vitro* digestibility was analyzed by Tilley and Terry (1963). Fistula cow rumen fluid was diluted using McDougal Buffer (1:4) and dispensed into a 1 g substrate-prepared incubation tube, which was purged with CO_2 to maintain an aerobic condition. The tubes were incubated in a water bath at 39°C for 24 h. After fermentation, the erlenmeyer tube containing the sample was inserted into ice water to stop the fermentation. All samples were then centrifuged at 1,200 rpm for 15 min. The pH, NH_3-N and total VFA of the supernatants were then recorded. The NH_3-N concentration was measured using the micro-diffusion conway method and the total VFA concentration was measured using the steam distillation method. The previously incubated samples were vacuum filtered (Whatman No. 41) and dried at 60°C in an oven. The dried samples were used to analyze the NDF, ADF and cellulose in the ***in vitro digestibility assay.

Table 1. The composition of concentrates using in complete ration

Composition	Requirement (%)
Corn	33
Rice bran	30
Palm kernel cake	35
Urea	0.5
Mineral	1.0
Salt	0.5
Total	100

Experimental design and statistical analysis: The study using Randomized Block Design (RBD) consisted of 4 treatments and 4 replication. The treatment provided were A: 30% of Fermented oil palm trunk plus 70% concentrates; B: 40% of fermented oil palm trunk plus 60% concentrates; C: 50% of fermented oil palm trunk plus 50% concentrates; D: 60% of Fermented fermented oil palm trunk plus 40% concentrates.

RESULTS AND DISCUSSION

Chemical composition: The chemical composition of oil palm trunk (OPT) and fermented oil palm trunk (FOPT) using *Phanerochaete chrysosporium* can be seen in Table 1. In Table 1, showed that fermentation can be decrease the dry matter. organi matter, crude fiber and fiber fraction (ADF, NDF and cellulose), however crude protein increase. This research supported by Zhao *et al*., (2015) stated that all fungi caused a net loss in DM, OM, NDF and ADL, and concequently in cellulose and hemicellulose of the rape straw during fermentation. Tripathi *et al* (2008) added that *Phanerochaete chrysosporium* was effective in degrading lignin of mustard straw and resulted in lignin loss of approximate 40% at 35 days incubation. In this research lignin decreased about 43.48% at 21 days incubation. The increase of crude protein after fermentation approximate at 47%, caused by the enzyme produced during fermentation like laccase, mangan peroxidase and lignin peroxidase.

Degradability of dry matter, **organic matter *in vitro***: Increased levels of fermented oil palm trunk (FOPT) and decreased levels of concentrate had a highly significant effect on degradability (P<0.01), with decreases in dry matter and organic matter degradability as shown in Table 4. The average degradability ranged from 55.54-67.58% for the degradability of dry matter, 55.61-67.72% for the degradability of organic matter.

Table 4, shows a trend of decreased degradability of dry matter, and organic matter from treatment A to D. The decrease in dry matter and organic matter degradability was caused by the differences in crude fiber content and lignin content of each treatment. Imsya *et al.* (2013) stated that the degradability of dry matter and organic matter decreases because of high levels of crude fiber content in the ration. Treatment D showed the highest lignin contents (13.6%) and the lowest dry matter, organic matter and crude fiber fraction (Table 3). These results suggested that although FOPT were fermented using *P. Chrysosporium* which decreased the lignin content, the nutritional value produced by the fermentation process was not able to achieve the nutritional value of rations (Table 3). It has been shown that lignin prevents polysaccharide digestion in the rumen and physically blocks hydrolytic enzymes produced by the rumen microorganism from affecting tissues with high digestibility (Albores *et al.*, 2006) while fungi, with their exoenzymes like laccase, oxidase, aromatic cycles and aliphatic chains, oxidate lignin to produce products with low molecular weight (Alemawor *et al.*, 2009; Ravindran and Jaiswal, 2016).

Table 2. Chemical composition of oil palm trunk (OPT) and fermented oil palm trunk (FOPT) using *P. chrysosporium*

Items (% DM)	Oil palm trunk (OPT)	Fermentet oil palmtrunk (FOPT)
Dry Matter	49.54	33.41
Organic Matter	87.56	74.60
Crude Protein	3.64	5.37
Crude Fiber	44.43	31.34
ADF	75.75	57.24
NDF	96.10	75.20
Cellulose	55.33	46.12
Hemicellulose	20.35	7.96
lignin	15.41	8.71
Silica	5.02	2.41

Description: All nutrient contents of the complete rations determined by Proximate and Van
Soest analysis at the Laboratory of Ruminant Nutrition, Faculty of Animal
Sciences, Andalas University (2017)

Fermentation of OPT with *P. chrysosporium* for 21 days showed a good lignin degradation rate. The content of lignin of OPT without fermentation was 15.41%, whereas lignin content of fermented OPT was 8.71% . This result showed that although the lignin content could be reduced by the fermentation process, the lignin content remained higher. Thus, at the high levels of FOPT used in the complete rations, the levels of digestibility remained low. The high degradability of ration A suggested that this combination of FOPT and concentrates was more easily degraded by rumen microbes than the other treatments. Low lignin content is very helpful for rumen microbial breakdown of cellulose and hemicellulose feed. The pattern of degradability of organic materials follows that of dry matter degradability, i.e., the low degradability of the dry matter causes the low degradability of organic materials. Thus, an increase in the degradability of dry substrate materials is followed by an increase in the degradability of organic substrate materials (Zain *et al.*, 2011; Zain *et al.*,2015)

The values of dry matter degradability (DMD) and organic matter degradability (OMD) in this study are higher than those in the treatment of 100%

Table 3. Proximate and Van Soest analysis of the complete rations with improvement of fermented oil palm trunk (FOPT)

Items (% DM)	Rations complete with fermented oil palm trunk			
	A	B	C	D
Dry Matter	90.29	88.88	86.28	86.55
Organic Matter	93.02	91.85	89.78	87.33
Crude Protein	12.18	11.55	8.17	7.19
ADF	47.84	46.58	44.19	42.70
NDF	65.37	64.16	63.97	60.92
Cellulose	35.87	32.92	31.36	34.78
Hemicellulose	17.47	18.58	18.98	19.22
lignin	10.29	11.79	12.76	13.16
Silica	1.68	1.87	1.92	2.03

Description: All nutrient contents of the complete rations determined by Proximate and Van Soest analysis at the Laboratory of Ruminant Nutrition, Faculty of Animal Sciences, Andalas University (2017) *in vitro* FOPT used by Marlida *et al*. (2016). This is because this treatment combines several feed ingredients such that the composition of nutrient substances donated, particularly the mineral content and amino acids, was more complete. Minerals and more complex amino acids optimize the metabolic activities in the rumen. Rumen microbes also optimally degrade feed ingredients, resulting in increased dry matter and organic matter degradability.

Degradability of fiber Fraction *in vitro*. Degradability NDF, ADF and cellulose obtained in this study was also significantly affected (P<0.01) by improvement of fermented oil palm trunk in the rations . NDF, ADF and cellulose were fiber from the carbohydrate fraction of potential as a source of energy for ruminants. In Table 4, can be showed that decreased digestibility of NDF, ADF and cellulose with inreased the fermented oil palm trunk in the ration caused by increased lignin and fiber contents (Callaway and Martin, 1997).

Rumen liquid characteristics: The results obtained showed that increased of fermented oil palm trunk (FOPT) in the rations complete did not affect of rumen pH. The relatively stable rumen pH for growth of rumen microbes, especially cellulolytic bacteria causing growth to be better so the fiber fraction digestibility also increased. It is also reported by several researchers such as Miller *et al*. (2002) and Fadel (2007). Total VFA production showed that the highly significant effect with increased FOPT (P<0.01). Total VFA concentration decreased with the increased FOPT. Decreased VFA production is associated with low activities of microbes in the rumen because inhibit by high lignin content of rations. Zhao *et al.* (2015) found that production of total VFA during ruminal fermentation is indicative of availability of fermentable energy from the rations, its means the increased FOPT in the rations did not availability of fermentable energy.

NH3 concentration of rumen fluid obtained in this study was significantly affected by treatment (P <0.01). NH3 produced decreased from 17.38 to 16.52 mM due to increased FOPT. The concentration of NH_3 is one indicator that determines feed fermentability which is related to protein digestibility, rumen microbial activity and rumen microbial population (Singh and Chen, 2008), it can be concluded that the availability of N-NH_3in the rumen fluid in the four treatments is within the normal range of NH_3 availability. These values included the value for optimum rumen microbial growth needs, the concentration of ammonia needed to support microbial growth 6-21 mM (Stewart, 1991). A decrease in rumen ammonia production due to an increase incorporation of ammonia into the protein microbial occurred when the microbial populations were also increasing. It is also founded by El-Waziry *et al*. (2000) and El-Ghani (2004). While ammonia is the main compound for the synthesis of microbes in the rumen.

CONCLUSION

Based on the results of this study, it can be concluded that the use of 40% of fermented oil palm trunk and 60% concentrate (B ration) can be used as ruminant feeding, whereas the *in vitro* degradability were: 67.39%, 67.52% for DM and OM, repectively. Fiber fraction degradability: 43.03, 54.13, and 58.26 for ADF, NDF and cellulose, respectively. The rumen characteristic were: 6.89, 18.49 (mg/100), 98.75 (mM) for pH, NH3 and VFA, repectively.

Table 4. Degradability of the rations complete based offermented oil palm trunk

Variables	Ration complete with increased of fermented oil palm trunk			
	A	B	C	D
pH	6.94	6.89	6.85	6.76
N-NH3 (mM)	17.38	18.49	18.28	16.52
VFA (mM)	87.50[c]	98.75[a]	96.25[b]	77.25[d]
Dry Matter Digestibility (%)	67.58[a]	67.39[a]	63.46[b]	55.54[c]
Organic Matter Digestibility (%)	67.72[a]	67.55[a]	64.92[a]	55.91[c]
NDF Digestibility (%)	55.24[a]	54.13[a]	52.46[a]	47.01[b]
ADF Digestibility (%)	43.28[a]	43.03[a]	40.18[b]	38.06[b]
Cellulose Digestibility (%)	58.43[a]	58.26[a]	48.69[b]	45.49[b]

Means in the same row with different [a,b]letters are significant at p<0.05, NDF: Neutral detergent fiber, ADF: Acid detergent fiber

ACKNOWLEDGMENTS

Special thanks go to the Ministry of Education and Culture of the Directorate General of Higher Education of Indonesia for supporting this research with funding schemes PUPT in 2017 with contract number 050/SP2H/PL/Dit. Litabmas/II/2017. Thanks are also due to the Foreign Aid Seminar, which found an international seminar at the 20th International Conference on Animal Sciences and Nutrition that to be held from 19-21 April 2018 at Holiday in Paris.

REFERENCES

Albores, S., Pianzzola, M.J., Soubes, M. and Cerdeiras, M.P. 2006. Biodegradation of agroindustrial wastes by Pleurotus spp for its use as ruminant feed. *Electronic J.Biotechnology*. 9 : 215-220.

Alemawor, F., Dzogbefia, V.P., Oddoye, E.O. and Oldham, J.H. 2009. Effect of Pleurotusostreatus fermentation on cocoa pod husk composition: Influence of fermentation period and Mn 2+ supplementation on the fermentation process. African *J. Biotechnology*. 8 : 1950-1958.

AOAC, 2000. In: *Official Methods of Analysis of the Association of Official Analytical Chemists* 17th Edn. (Horwitz W, Ed.). AOAC International, Maryland, USA.

Awalludin, M.P., Sulaiman, O., Hashim, R. and Nadhari, W.A.W. 2015. An overview of the oil palm industry in Malaysia and its waste utilization through thermochemical conversion. *Renewable and Sustainable Energy*. *Reviews* 50 : 1469-84.

Callaway, E.S. and Martin, S.A. 1997. Effects of *Saccharomyces cerevisiae* culture on ruminal bacteria that utilize lactate and digest cellulose. *J. Dairy Sci*. 80 : 2035–2040.

El-Ghani, A.A. 2004. Influence of diet supplementation with yeast culture (*Saccharomyces cerevisiae*) on performance of Zaraibi Goats. *Small Ruminant Rest*. 52 : 223-229.

Elisashvili, V. and Kachlishvili, E. 2009. Physiological regulation of laccase and manganese peroxidase production by white-rot Basidiomycetes. *J. Biotechnol*. 144 : 37-42.

El-Waziry, A.M., Kamel, H.E.M. and Yacout, M.H.M. 2000. Effect of bakery yeast (*Saccharomyces ceresivisiae*) supplementation to Beerseem (*Trifolium alexandrinum*) hay diet on protein digestion and rumen fermentation of sheep. *Egypt J. Nutr. Feeds*. 3: 71-82.

Fadel, A.M.A. 2007. Effect of supplemental yeast (*Saccharomyces cerevisiae*) culture on NDF digestibility and rumen fermentation of forage sorghum hay in nubian goat's kids. *J. Agric. and Biol. Sci*. 3 : 133-137.

Imsya, A., Laconi, E.B., Wiryawan, K.G. and Widyastuti, Y. 2013. *In vitro* digestibility of ration containing different level of palm oil frond fermented with *Phanerochaetae chrysosporium*. *J Anim Sci Technol*. 36 : 131–136.

Marlida,Y., Arnim, and Roza, E. 2016. The effect of treated oil palm trunk by ligninase thermostable to improvement fiber quality as energy sources by ruminant. *International*. *J. Chemtech Research*. 9 : 09 429-36.

Miller, W., Hoover, T., Holt, W.H., M. and Nocek, J.E. 2002. Influence of yeast culture on ruminal microbial metabolism in continous culture. *J. Dairy Sci*. 85 : 2009-2014.

Sharari, M., Roohani, M., Latibari, A.J., Guillet, A., Aurousseau, M. and Sharari, A. 2013. Treatment of bagasse preparation effluent by *Phanerochaete chrysosporium* immobilized on polyurethane foam: Enzyme production versus pollution removal. *Ind. Crops Prod*. 46 : 226-233.

Sindhu, R., Binod, P. and Pandey, A. 2016. Biological pretreatment of lignocellulosic biomass–An overview. *Bioresource Technol*. 199 : 76-82.

Stewart, C.S. 1991. The Rumen Bacteria. In: Rumen Microbial Metabolism and Ruminant Digestion, Jouany, *J.P. (Ed.). INRA, Paris, France, pp*: 15-26.

Tilley, J.M.A. and Terry, R.A. 1963. A two-stage technique for the *in vitro* digestion of forage crops. *Grass Forage Sci*. 18 : 104-111.

Van Kuijk, S., Sonnenberg, A., Baars, J., Hendriks, W. and Cone, J. 2015. Fungal treated lignocellulosic biomass as ruminant feed ingredient: a review. *Biotechnol. Adv*. 33 : 191-202.

Van Soest, P.J., Robertson, J.B. and Lewis, B.A. 1991. Methods for dietary fiber, neutral detergent fiber and nonstarch polysaccharides in relation to animal nutrition. *J. Dairy Sci*. 74 : 3583-3597.

Zahari, M.W., Alimon, A.R. and Wong, H.K. 2009. *Utilization of oil palm co-products as feeds for livestock in Malaysia*. pp. 243– 302.

Zain, M., Jamarun, N., Arnim, A., Ningrat, R.W.S. and Herawati, R. 2011. Effect of yeast (*Saccharomyces cerevisiae*) on fermentability, microbial population and digestibility of low quality roughage *in vitro*. *Archiva Zootechnica*. 14 : 51-58.

Zain, M., Rahman, J., Khasrad and Erpomen, 2015. In vitro fermentation characteristics of palm oil byproducts which is supplemented with growth factor rumen microbes. *Pak. J. Nutr*. 14 : 625-628.

Zhao, X., Gong, J., Yang, K.O., Song, X., Fu, C., Xu, L. and Qu.M. 2015. Effect of fungal treatments of rape straw on chemical composition an in vitro rumen fermentation characteristics. *Bio Resources*. 10 (1) : 622-37.