International Journal of Science and Engineering(IJSE)

Home page: http://ejournal.undip.ac.id/index.php/ijse

The Nutrient Potency of Palm Oil Plantation and Mill's By-product Processedwith Amofer Technology as Ruminant Feed

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Abstract-*By-product derived from palm oil plantation and mill is very potential for energy and protein source for ruminant feed. However, it is still underutilized due to low content of crude protein (CP) with high crude fiber (CF). Ammoniation or fermentation technology could optimize the quality of by-product by increasing digestibility, reducing CF and increasing CP content. The objective of this research was to determine the nutrient and potency value of palm oil plantation and mill's by-product applied with amofer technology for ruminant feed. Sample was prepared in two methods: 1) sample without amofer application, 2) sample with amofer application under anaerobic method and incubated for 18 days. Ammoniation was carried out by adding urea of 3% from the total material and then incubated for nine days. At the ninth day, some microorganisms starter i.e. cellulolytic, amillolytic and proteolytic were added by 1% of the total material. Proximate analysis was carried out in laboratory to examine the nutrient value. The crude protein content at each part of feed material before and after amofer treatment was follow: palm midrib: 3.16%:17%; palm leaves 6.53%:26.51%; empty fruit bunch 7.01%:1673%; palm pressed fiber 5.56%:16.00%. While the crude fiber at each part of feed material was: palm midrib 37.85%:30.86%; palm leaves 30.39%:24.41%; EFB 40.22%:34.98%; PPF 50.39%: 41.70%. The application of amofer could increase the amount of feed material (ton/ha/y): dry matter (DM) 14.82:15.89; CP 0.79:2.87; total digestible nutrient (TDN) 7.63:8.5. Moreover, amofer application could also increase the nutrient content of palm oil plantation and mill's by-product by increasing CP and reducing CF. This increasing was also followed by the increasing of DM, CP, and TDN which indicated that those feed sources were recommended as ruminant feed material.*

Keywords*:By-product amofer, urea, anaerobic, nutrient, ruminant(;)*

Submission: December 28, 2013 Correction: March 25, 2014 Accepted: April 2, 2014

Doi: 10.12777/ijse.6.2.112-116

[How to cite this article: Mayulu, H. 2014. The Nutrient Potency of Palm Oil Plantation and Mill's By-product Processed With Amofer Technology As Ruminant Feed, *International Journal of Science and Engineering*, 6(2),112-116. Doi:10.12777/ijse.6.2.112-116]

I. Introduction

Optimization the uses of plantation area could be one effort to provide adequate amount of site specific feed for ruminant either in integration or diversification pattern. Crop livestock system is recognized as mutualism system as it increases the fertility both plant and soil. These fertility lead to the increasing of feed production over year and then subsequently increase the production and productivity of livestock (Riady, 2004; Kusnadi, 2008; Mayulu *et al*., 2010; Sunarso *et al*., 2011).

Utilization of palm oil by-product as high economic value feed source is a useful alternative and could reduce the environmental impact generated by palm oil. This is also recognized as an efficient method to produce economic product. Various researches stated that palm oil by-product is very potential for energy and protein source for ruminant. However, it still has low quality due to low content of crude protein (CP) with high crude fiber (CF) (Sutrisno, 2001; Sutrisno, 2002; Agricultural Research and Development, 2005; Harfiah, 2007).

Generally, forage produced in Indonesia has low quality which could not yield maximum productivity of livestock due to insufficient amount of energy, protein and mineral. Using technology approach, many of palm oil plantation and mill's by-product is potential to be utilized for ruminant feed source. Recent technology has shown the promising development of complete feed formulation based palm oil plantation and mill's by-product. The quality of palm oil plantation and mill's by-product could be optimized using ammoniation or fermentation method to increase the digestibility by reducing CF and increasing CP. Some previous researches reported that fermentation of palm kernel (PK) and palm oil sludge (POS) could increase CP up to 67% and reduced CF to 27% (Sutrisno, 200; Hardianto, 2003; Umiyasih and Anggraeni, 2007; Puastuti, 2008).

Ammoniation fermentation (amofer) is recognized as an applied technology where a combination of ammoniation and fermentation are carried out together with certain method and technique which uses urea and cellulolytic, amillolytic and proteolytic microorganism. Cellulolytic microorganism degrades complex carbohydrate of CF, amillolytic degrades simple carbohydrate and proteolytic degrades protein. Together, urea used in ammoniation process and microorganism used in fermentation process work to reduce CF and increase CP of feedstuff. This condition is closely related to the increased digestibility rate at the beginning of digestive process that affects the energy availability of adenosine triphosphate (ATP) which required during rumen microbial proliferation (Mayulu, 2012; Sudarmono, 2013).

Ammoniation has several advantages such as simple procedure, harmless, cheaper and easier to make compared to NaOH, effective to remove aflatoxin especially in rice straw, could increase CP and does not have pollution effect. The only one NH_3 substance which is cheap and easy to get is urea. Fertilizer is the common used of urea. Urea in the form of $CO(NH_2)_2$ is commonly used substance to formulate ruminant feed due to the availability, cheap and less toxicity compared to biuret. The physical form of urea is white color and hygroscopic. Urea contains nitrogen of 42-45% which equal to CP ranges from 262-281%. Three kinds of ammonia sources that can be used are NH_3 in the form of liquid gas (anhydrous), NH_4OH in the form of solution (aqueous) and urea in the form of solid $CO(NH_2)_2$. Among of those three sources, urea is the most widely used. Urea is recognized as nitrogen source that can be fermented. Urea contains 46% nitrogen so that 1 kg urea equals to 2.88 kg CP (6.25 x 46%) and the hydrolysis yields 0.57 kg ammonia gas (Caneque *et al.*, 2000; Ribeiro, 2000; Andajani, 2010).

Fermented palm oil plantation and mill's by-product could run effectively if certain microbe is added as inoculant. Some effective inoculant or fermenter for plantation waste fermentation is *Aspergilus niger*, *Tricoderma* and *Rhizoplus*. *Aspergilus niger* is a facultative fungus which can growth under aerobic or anaerobic environment. Thus, the uses of this fungus will be more practical since fermentation process does not require closed system (Wina, 2005; Akbar, 2007). Application *Aspergilus niger* for fermentation process has been widely used in Animal Research Center in Ciawi, Bogor. This fermentation process increased CP from 12.2% to 24.5% DM and metabolic energy also increased from 1.6 kkal/g to 1.7 kkal/g. The application of fermentation technology still needs to be improved in order to optimize the nutrient content of feedstuff (Guntoro, 2005; Mathius *et al.*, 2004; Wina, 2005; Mathius, 2008).

This research was aimed to determine the nutrient content and potency of by-product derived from palm oil plantation and mill processed with amofer technology as an alternative ruminant feed source.

II. RESEARCH METHOD

Sample consisted of palm midrib, leaaves, *Centrosema sp.*, empty fruit bunch (EFB), palm pressed fiber (PPF), palm kernel (PK), and palm oil sludge (POS). All samples was obtained from PTPN XIII, Long Ikis district, Paser regency, East Kalimantan province. Sample preparation was carried out directly in the field site and transported to the Laboratory of Animal Nutrient and Feed, Faculty of Animal and Agriculture, University of Diponegoro. Sample was arranged into two groups: 1) First, sample without amofer treatment, and 2) second, sample including palm midrib, leaves, EFB and PPF were treated with amofer (Fig. 1). The first sample was carried out to examine the original nutrient of site specific material.

The first step was to mill all sample material using 0.5 mm sieve grinder. Proximate analysis was carried out to determine the nutrient composition and proportion of sample material consisting palm midrib, leaves, *Centrosema sp.*, EFB, PK, and POS. *Centrosema sp.*, PK and POS did not experience amofer treatment due to high nutrient amount of CP.

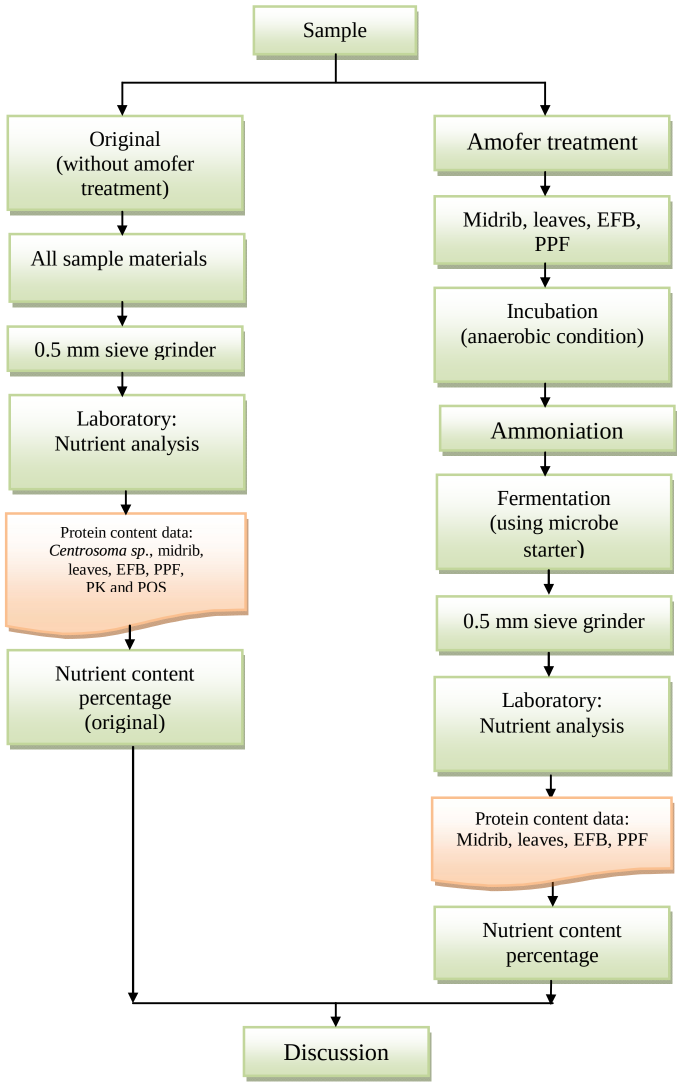

Figure 1. Research Flow Chart

Sample including palm oil midrib, leaves, EFB and PPF experienced amofer treatment to increase the nutrient content. Amofer process with anaerobic incubation was carried out using black plastic sizes of 100 x 85 cm. Fermentation was carried out for 18 days under these following steps: 1) Ammoniation using urea supplementation by 3% from total material at the first day of treatment (Musalia *et al*., 2000) and then incubated for nine days in plastic with 25-30 kg capacity; 2) Fermentation, microbe starter such as cellulolytic microorganism, amilolytic and proteolytic was added at the ninth day by 1% of the total material and then incubated. Adequate water was added during amofer process. The palm midrib, leaves, EFB, and PPF were then removed from plastic and tempered after completing amofer process. The next step was to mill the material using 0.5 mm sieve grinder to obtain uniform size and surface area. The following step was proximate analysis to determine the nutrient value of material.

III.RESULT AND DISCUSSION

Exploration of feed source derived from palm oil plantation and mill gains attention for providing sufficient amount for ruminant feedstuff. Those could be conducted by direct utilization or processed using amofer technology (Fig. 2). Proximate analysis showed that feedstuff without amofer technology had sufficient nutrient amount ranging from 3.16–17.86% of CP. In term of DM, CP, and TDN; the result showed that by-product materials derived from palm oil plantation and mill were potential for feed source (Table 1).

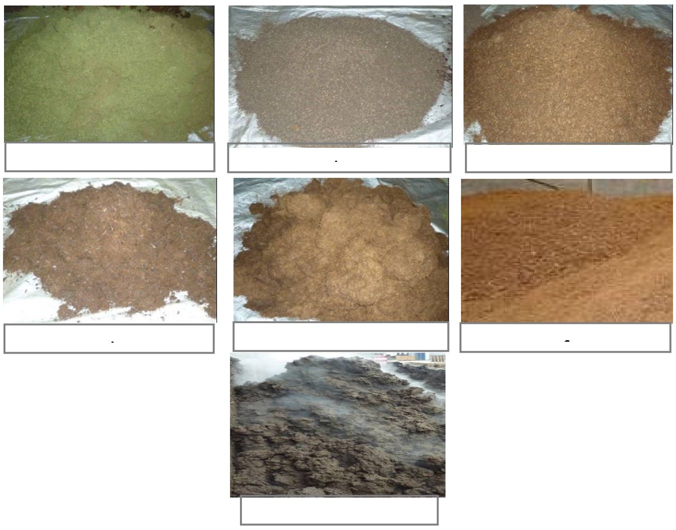

Fig 2. Palm oil plantation and mill's by-product as feed material (a. *Centrosoma sp.*; b. Palm leaves; c. Palm midrib; d. Palm empty fruit bunches; e. Fiber fruit juice; f. Palm kernel and g. Palm oil sludge

Table 1. Original Nutrient of Palm Oil Plantation and Mill's By-product (Mayulu *et al*., 2013)

Feed material	Nutrient composition (%)							
	Water[1]	DM[1]	Ash[1]	Crude fat[1]	CF[1]	CP[1]	BETN	TDN[2]
Palm midrib	37.62	62.38	3.63	3.50	37.85	3.16	51.86	51.32
Palm leaves	39.60	60.40	10.36	1.95	30.39	6.53	50.77	56.20
Centrosema sp.	64.18	35.82	10.89	4.30	5.12	22.58	27.11	49.67
Empty fruit bunch	35.40	64.60	12.09	1.14	40.22	7.01	39.54	46.92
Palm pressed fiber	34.56	65.44	5.78	3,18	50.36	5.56	35.12	40.45
Palm kernel	5.06	94.94	3.19	7,86	10.45	15.49	63.01	82.53
Palm oil sludge	45.89	54.11	15.79	6.06	45.99	17.86	14.31	47.81

[1]Proximate analysis result conducted in Animal Nutrient and Feed Laboratory, Faculty of Animal and Agriculture, Diponegoro University
[2]Calculation result Sutardi (2001)

Feedstuff including palm oil midrib, leaves, EFB and PPF were treated with amofer technology. While others materials including CP and POS did not experience amofer treatment due to higher nutrient content. Amofer technology increased nutrient and CP content and reduced CF content of feedstuff (Table 2). This result also has implication for the improvement of nutrient potency and carrying capacity of feed resource derived from palm oil plantation and mill's by-product.

Table 2. Analysis Result of Ammoniated and Fermented Feedstuff

Feedstuff	Nutrient composition (%)							
	Water[1]	DM[1]	Ash[1]	Crude fat[1]	CF[1]	CP[1]	BETN	TDN[2]
Palm midrib	35.84	64.16	5.36	3.02	30.86	17.00	43.77	58.94
Palm leaves	35.08	64.92	5.62	1.80	24.41	26.51	41.65	61.40
Empty fruit bunch	34.34	65.66	14.65	4.89	34.98	16.73	28.75	56.13
Palm pressed fiber	26.58	73.42	6.33	4.14	41.70	16.00	31.82	50.39

[1]Proximate analysis result conducted in Animal Nutrient and Feed Laboratory, Faculty of Animal and Agriculture, Diponegoro University
[2]Calculation result Sutardi (2001)

In term of DM, CP and TDN, by-product derived from palm oil plantation and mill without amofer treatment was potential for ruminant feed source but not as good as feed material with amofer treatment. The analysis result is shown in Table 3.

Table 3. Dry Matter, Crude Protein and Total Digestible Nutrient content of Palm Oil Plantation and Mill's By-product in PTPN XIII East Kalimantan (Mayulu *et al*., 2013).

By product	Dry Matter		Crud Protein		Total Digestible Nutrien	
	ton/ha/y	Proportional average (%)	ton/ha/y	Proportional average (%)	ton/ha/y	Proportional average (%)
Palm midrib	8.76	59.09	0.28	35.27	4.49	58.92
Palm leaves	1.53	10.31	0.10	12.72	0.94	12.29
Centrosema sp.	0.37	2.48	0.08	10.60	0.18	2.40
Empty fruit bunch	3.62	24.41	0.25	32.32	1.70	22.25
Palm pressed fiber	0.18	1.23	0.01	1.29	0.07	0.96
Palm kernel	0.19	1.29	0.03	3.77	0.16	2.06
Palm oil sludge	0.18	1.20	0.03	4.04	0.08	1.11
Total	14.82	100	0.79	100	7.63	100

Ammoniation-fermentation on palm midrib, leaves, EFB and PPF increased the content of DM, CP and TDN. The application of amofer not only increased the quality but also increased the quantity. This could be seen in DM which increased from 14.82 to 15.89 ton/ha/y; CP from 0.79 to 2.87 ton/ha/y and TDN from 7.63 to 8.51 ton/ha/y. This increment associated with the increasing of weight due to supplementation of urea and microbe starter even with insignificant amount (Table 4).

Palm leaf without amofer treatment had lower quality and its rough characteristic had no advantage for animal. Ammoniation, molasses addition, alkali, silage formulation, high vapor pressure, pallet and enzymatic process are proven technologies to increase the nutrient amount and biological quality of palm midrib (Batubara *et al*., 2003; Ginting and Elisabeth, 2004; Azmi and Gunawan, 2006; Mahgoub, *et al*., 2007).

Table 4. The content of DM, CP and TDN of Palm Oil Plantation and Mill's By-product Processed with Amofer Technology

By product	DM		CP		TDN	
	ton/ha/y	Proportional average (%)	ton/ha/y	Proportional average (%)	ton/ha/y	Proportional average
Palm midrib	9.38	59.05	1.59	55.56	4.88	57.42
Palm leaves	1.71	10.78	0.45	15.82	0.95	11.15
EFB	3.83	24.12	0.64	22.34	2.15	25.29
PPF	0.22	1.39	0.04	1.23	0.09	1.10
PK	0.19	1.22	0.03	1.05	0.16	1.89
POS	0.18	1.12	0.03	1.10	0.08	1.00
Centrosema sp.	0.37	2.32	0.08	2.90	0.18	2.15
Total	15.89	100	2.87	100	8.51	100

According to Mathius (2003) and Hanafi (2004), the addition of urea had higher capability to increase the content of DM, CP and digestibility of silage-based palm leaf compared to silage without urea application. Its application on cattle could increase the DM content by 45%. Moreover, Batubara, (2003), Mathius *et al*. (2004) and Utomo (2004) also stated other advantages of urea application in ammoniation process i.e. ease procedure and could increase the nutrient value of feedstuff. Palm leaf with ammoniation process could increase crude protein content ±2.0% and digestibility by 4–5 times. Silage with addition of urea or molasses has not given satisfactory result although it could increase the nutrient value.

Ammoniation method using ammonia gas, hydroxide ammonia or urea to increase the digestibility of cattle is regarded as an applicable method. Adequate supply of ammonia nitrogen (NH_3N) in rumen is required to optimize the digestibility of low quality fermented feed that will support the growth of rumen microbe. Urea has been widely applied by individual farmer or enterprise in small scale farming particularly in development country. Reducing urea application from 4 to 2% and combined with hydroxide calcium 0.5% will give lower rumen degradation compared to ammonia treatment. However, this treatment gives higher added value (Galina *et al*., 2004; Elseed, 2005).

Urea is recognized as good protein source for cattle and sheep's offspring growth. In accordance with Musalia *et al.* (2000), this research used urea 3% for protein source in ammoniation process of CP. Haryanto *et al.* (2001) also proved that urea 3% in ammoniation process of fermented dried cassava waste pulp could increase nitrogen balance and energy digestibility of sheep.

Addition of particular microbe as inoculant is required to increase the effectiveness of fermentation process of palm oil plantation and mill's by-product. During fermentation process, microorganism produces such of enzyme which activate chemical reaction. This changes complex molecule or organic compound such as protein, carbohydrate and fat into simpler molecule that are easily digested. Fermentation also changes other nutrient compound such as amino acid and vitamin on the raw material. Fermentation could produce better aroma, increase the shelf life and reduce the toxic content of raw material that would give higher economic value (Nirwana, 2005; Oji *et al.*, 2007).

Ammoniated-fermented feedstuff including palm midrib, leaves, EFB and PPF together with non-ammoniated-fermented material including CP, POS and *Centrosema sp*. could be made into CF with addition of corn, rice bran, dried cassava waste pulp, molasses, urea mineral and salt. According to Mayulu *et al*. (2012), all feed material derived from palm oil plantation and mill's by-product that were used for CF 40% with protein level 14% was very palatable and did not give negative effect on blood profile and kidney function of local sheep. Thus, it is recommended as an alternative source for site specific feedstuff.

CONCLUSION

Ammoniated-fermentation treatment increased the nutrient content of palm oil plantation and mill's by-product which showed by the increasing content of protein and decreasing content of crude fiber. This increasing was followed by the increasing of DM, CP and TDN. Thus, it was recommended to use this feedstuff as ruminant feed source.

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