Optimizing Rumen Bioprocess through Supplementation of Microbe Precursor Nutrient in Ammoniation of Palm Oil Frond-Base Cattle Ration

Nurhaita[1], Ruswendi[1], Wismalinda R[1], and Robiyanto[2]
[1]Agricultural Faculty of Muhammadiyah University, Bengkulu, Indonesia
[2]BPTP Bengkulu Jl. Irian Km 6,5 Bengkulu
Email: {ruswendi, robiyanto}@yahoo.com; {nurhaita, vinnagita}@gmail.com

***Abstract*—This research aimed at evaluating the effect of supplementation of cassava leaf meal and S and P mineral in ammoniated palm oil frond towards the bioprocess optimization in cattle rumen. Randomized block design was used applying 5 ration treatments and 4 cattle groups. Treatment ration were A: field grass, as control group; B: ammoniated palm oil frond; C: B + 5% cassava leaf; D: B + 0.4% mineral S and 0.27% mineral P; and E: B + cassava leaf + S and P mineral. The measured parameters covered: 1) bacteria population, 2) digestibility of dry matter and organic matter. Result showed that cassava leaves and mineral supplementation, could increase bioprocess optimization in the rumen as observed from the increase of rumen bacteria population, digestibility of dry and organic matter. The highest bacteria population was found in ration of ammoniated palm oil frond by supplementing cassava leaves and S, P mineral.**

***Index Terms*—ammoniated palm oil frond, digestibility, rumen bacteria population, supplementation of mineral s, p and cassava leaf,**

I. Introduction

The main problem of cattle business is obtaining the sufficient greens, owing to the ever- decreasing grass field in transition to housing complex, industrial and plantation area. On the other hand, the extension of plantation area results in great amount of waste. The use of its waste, palm oil frond for instance, is an alternative to solve the scarcity of greens supply

Palm oil frond is potential of alternative greens for ruminants. Indonesian plantation area in 2010 was 7.500.000 ha [1], producing annual 10.4 ton/ha dry matter of palm oil frond with as many as 78.000.000 ton dry waste. It was enough to meet the need of 24.422.700.6 cattle per year. This number will increase as the palm plantation area expands. It shows a potential as the source of greens substitute for grass especially for cattle. Palm oil frond waste, however, has not been processed optimally due to the low digestibility.

Manuscript received March 17, 2014; revised May 20, 2014.

To gain optimum function, palm oil frond waste needs to undergo certain process whose technique including physical, biological, and chemical elements proven to increase beneficial value of the waste [2]-[9]. Despite the low value of digestibility and less optimality to support cattle production. Therefore, processing technique needs to combine in order to increase digestibility by increasing the population of rumen microbe since fiber digestibility is strongly related to enzyme produced by rumen microbe. This can be done by providing nutrient precursor microbe protein synthesis namely energy, nitrogen, mineral and amino acid.

Mineral S and P that is essential to rumen microbe digesting fiber is often deficient in feed made of farming or plantation waste and become the hindrance of rumen microbe growth. This is because feed in tropical area and from plantation and farming waste is deficient in essential mineral for microbe growth namely S and P [10] besides the mineral bioavailability in this fiber feed is low.

All microba need mineral P to maintain the integrity of cell membrane, is a nucleate acid component and part of high energy molecul (ATP, ADP etc) [11],[12] Mineral S is the essential element to support the formation of amino acid containing sulfur and microbe protein synthesis. It is also important to synthesize several vitamins (thiamine and biotin) and coenzyme (COASH) [10] Mineral S and P deficiency will affect the degradation of food substance component and microbe protein.

Supplementation of mineral S to ammoniated and non-ammoniated rice bran showed an increase of microbe synthesis and cellulose digestibility [13], [9]. Study by [14] reported that in vitro supplementation of P mineral in for of phosphate was able to increase NDF digestibility of bagasse. In vitro supplementation of mineral S and P in ammoniated palm oil frond could increase its digestibility as much as 36.68% from 34.67% to 47.39% [5]

Besides mineral, celluloid rumen bacteria also needs Branched-Chain fatty acids (BCFA) consisting of isobutyric acids, 2 methyl butyric, and valeric acid as

doi: 10.12720/joaat.1.1.10-13

the source of carbon frame for bacteria, resulted from decarboxylation and deamination from Branched – Chain Amino Acid (BCAA). BCAA in rumen is mostly from fermentation of lytic ration protein and microbe rumen. In low quality waste as palm oil frond, BCAA content is low, supplementation of BCAA is therefore needed in the ration comprising valine, isoleucine, and leucine which can increase rumen microbe population and palm fiber digestibility [15]

An inexpensive and readily available natural source of BCAA is cassava leaf which contains high crude protein with 0.45% amino isovaline acids, 0.46% isoleucine, and 0.63% leucine [16]. Addition of cassava leaf meal as much as 5% in ammoniated palm oil frond, previously supplemented with mineral S and P, could increase digestibility mainly of the dry matter as much as 24.09% and ADF digestibility increased 44.35%, in vitro[17], [18] reported that the use of cassava leaf meal as the source of Branched-Chain Amino Acids (valine, leucine, isoleucine) in feed made of ammoniated palm fiber could restore feed digestibility and cattle growth.

This research aimed to evaluate the influence of supplementation of rumen microbe precursor nutrient on ration of ammoniated palm oil frond towards the optimizing of rumen bioprocess in cattle.

II. Materials and Method

In vivo research located in the cage of Technical Operation Unit (UPT) of Pembibitan Dinas Peternakan dan Kesehatan Hewan Bengkulu for four months from 25 April 2011 to 28 August 2011. Sample analysis (proximate and Van Soest analysis) was conducted in Balai Penelitian Ternak (Balitnak) laboratory, Ciawi Bogor.

20 Bali male cattle of 1.5-2.0 years old and 126 $\pm$ 43 kg were kept in treatment cage, divided into four groups based on body weight and randomly given five ration treatments. Ration consisted of greens and concentrate in 50:50 ratio. Concentrate was composed of rice bran, solid, salt and lime, while greens was of field grass for control group and palm oil frond ammoniation. All the ration ingredients, chemical component of the ration and chemical component of treatment ration was observable in Table I-Table III. The equipment used was cage and utility, metabolic scale, laboratory utility.

TABLE I. Proportion of Materials Rations (% DM)

Foodstuffs		Ration			
	A	B	C	D	E
Field Grass	50,0	0,00	0,00	0,00	0,00
Palm Frond Ammoniation	0,00	50,0	50,0	50,0	50,0
Rice bran	40,0	40,0	40,0	40,0	40,0
Solid	9,0	9,0	9,0	9,0	9,0
Salt	0,5	0,5	0,5	0,5	0,5
Lime	0,5	0,5	0,5	0,5	0,5
Total	100	100	100	100	100
Suplementation					
* Sulfur	0,00	0,00	0,00	0,40	0,40
* Phospor	0,00	0,00	0,00	0,27	0,27
* Cassava Leaf	0,00	0,00	5,00	0,00	5,00

TABLE II. Chemical Composition of Rations Ingredients (% DM)

Nutrient	Field Grass	PFA	CLM	Rice Brand	Solid
Dry Matter	20,16	40,31	90,51	90,25	19,29
Organic Matter	91,69	88,62	91,94	90,59	89,58
Crude Fiber	32,57	42,19	17,91	15,38	24,68
Crude Protein	9,10	13,04	19,21	14,00	13,77
Crude fat	1,92	2,46	8,23	14,56	11,11
Energi (Kkal/kg)	3917	3839	4464	4429	4324
Sulfur	0,20	0,1,5	0,25	0,17	0,26
Phospor	0,25	0,12	0,26	0,91	0,78
Calsium	0,14	0,47	1,19	-	1,66
*Valin	-	0,58	0,45	-	-
*Isoleusin	-	0,32	0,46	-	-
*Leusin	-	0,59	0,63	-	-

Note : analysis results of Lab. Balitnak Ciawi, Bogor. 2011
*Nurhaita,2008

PFA= Palm Frond Ammoniation, CLM = Cassava Leaf Meal

TABLE III. Chemical Composition of Ration (% DM)

Nutrient	Ration				
	A	B	C	D	E
Dry Matter	48,01	58,09	62,60	58,09	62,60
Organic Matter	90,59	89,06	93,65	89,06	93,65
Crude Fiber	24,78	29,59	30,49	29,59	30,49
Crude Protein	11,46	13,43	14,39	13,43	14,39
Crude fat	7,84	8,11	8,52	8,11	8,52
Energi (Kkal/kg)	4140,88	4101,88	4325,08	4101,88	4325,08
Sulfur	0,19	0,17	0,18	0,57	0,57
Phospor	0,56	0,50	0,51	0,77	0,77
Calsium	0,18	0,35	0,40	0,35	0,35
*Valin	-	-	0,31	-	0,31
*Isoleusin	-	-	0,18	-	0,18
*Leusin	-	-	0,33	-	0,33

Note: Calculated based on Table I and Table II

A. Research Method

This research applied Randomized Block Design with five ration treatments and four groups of Bali male cattle as the repetition. Cattle grouping was based on body weight at the start of the experiment; the groups were; I: 95 $\pm$ 10 kg; II: 115 $\pm$ 10 kg; III: 135 $\pm$ 10 kg and IV: 157, 5 $\pm$ 12,5 kg.

Five ration treatments were:

A = field grass + concentrate (50:50) as control
B = ammoniated palm oil frond + concentrate (50:50)
C = B + 5% cassava leaf meal
D = B + supplement mineral S (0,4%) and P (0,27%)
E = B + S and P mineral + cassava leaf meal

Research design by [19] was:

$$Y_{ij} = \mu + K_j + P_i + \epsilon_{ij} \quad (1)$$

All data were analyzed using ANOVA and difference among treatments was tested using

Duncan Multiple Range Test (DMRT).

B. The Observed Variables

1. Total Population of rumen bacteria (10^9 /g)
2. Dry matter and organik matter digestibility (%),

III. Result and Discussion

A. Total Population of Rumen Bacteria.

Table IV shows that the lowest total population of bacteria was in control treatment ration (grass). In ammoniated palm oil frond ration (treatment B) there was an increase of total population of bacteria as much as 7.6% than in control ration (7,84 x 10^9/g vs. 8,44 x 10^9/g). The total population of bacteria in ammoniated palm oil frond is, however lower than that supplemented with cassava leaf meal, mineral S and P, or both. It showed the low activity and amount of microbe in rumen due to lack of nutrient for microbe growth. For optimum growth, bacteria therefore need not only nitrogen but also other nutrition as energy, mineral, amino acids.

TABLE IV. TOTAL POPULATION RUMEN BACTERIA, DRY MATTER DIGESTIBILITY AND ORGANIC MATTER DIGESTIBILITY

Parameter	Ration					SE
	A	B	C	D	E	
Population.Rumen Bacteria (x10^9)	$7,84^a$	$8,44^{ab}$	$10,50^c$	$9,24^b$	$15,23^d$	0,14
DMD (%)	$59,02^c$	$42,81^a$	$45,38^b$	$44,89^b$	$44,90^b$	0,37
OMD (%)	$62,2^c$	$47,20^c$	$48,89^b$	$48,67^b$	$49,15^b$	0,24

Note : Different superscripts in the same row indicate significantly different (P <0.05), SE = Standard Error

Supplementation of cassava leaf meal in ration C increased the total population of rumen bacteria as much as 24.41% compared to that in ammoniated palm oil frond without supplementation (8.44 x 10^9/g vs. 10.50 x 10^9/g). It was proven that celluloid bacteria were highly responsive to the addition of branched carbon frame. Cassava leaf meal is the source of carbon frame needed to stimulate the growth of celluloid bacteria. Without carbon frame, urea or nitrogen, ammonia could not serve for rumen microbe protein synthesis.

This research observed that rumen microbe was more responsive to the addition of Branched – Chain Amino Acid than the addition of mineral S and P as seen from the higher total population of rumen bacteria than in the ration supplemented with cassava leaf meal (10, 50 x10^9/g) than ration supplemented with mineral S and P (9, 24 x 10^9/g). This was due to the avai- lability of nutrient for microbe balanced growth. Without mineral S and P supplementation, mineral level in ration C was 0.18% of sulfur and 0.51% for phosphor. Mineral S level has been in accordance to the [20] but mineral P level was higher than the recommended level of mineral required by [20].

Supplementation of sulfur and phosphor in ration D could increase the total population of rumen bacteria as much as 9.48% compared to treatment B (9.24 x 10^9/g vs 8.44 x 10^9/g). This was due to the revitalization of rumen by sulfur and phosphorus mineral supplementation, leading to the increase of rumen microbe activity which later affected digestibility.

Sulfur and phosphorus supplementation in ration D caused S and P mineral in ration turned 0.57% and 0.77%, respectively from the dry matter. This was higher than the standard required mineral namely 0.14 – 0.26% for sulfur and 0.16 – 0.38% for phosphor [20]. Despite the higher amount than the standard, mineral bio-avalibility in the ration was low, as seen from the increase of the total population of rumen bacteria in lower supplementation of mineral S and P than supplementation of cassava leaf meal or supplementation of both. Besides, types of mineral and form of mineral supplementation highly influenced the result.

Supplementation of cassava leaf meal along with the mineral in ration E caused the total population of rumen bacteria increased as much as 80.45% than palm oil frond without supplement (8.44 x 10^9/g vs 15.23 x 10^9/g). The increase of total population of rumen bacteria was due to sufficient and balanced nutrient. The result showed that nutrient supplementation must be in accordance to the availability of other nutrient. The best increase of bacteria population was obtained in ration containing all nutrients needed by the rumen microbe, namely nitrogen of ammonia from ammoniated palm oil frond, sulfur and phosphor from mineral supplement and branched carbon frame from branched chain amino acids in cassava leaf meal. The increase of rumen bacteria population had a double effect, namely increasing the digestibility of fibrous feed due to the increase of enzyme produced by microbe, and increasing the supply of microbe protein for the host.

B. Dry Matter and Organic Matter Digestibility

Digestibility value of substance in ammoniated palm oil frond was significantly lower than the other treatments. This proved the low activity and amount of microbe in rumen. Although the ammonia in this treatment was highly available, it was still insufficient to increase the growth of bacteria in rumen. This was due to insufficiency of other nutrient for microbe growth. It was proven that bacteria growth required not only nitrogen but also other nutrient such as energy, mineral and amino acids.

Digestibility of dry matter and organic matter in ration supplemented by cassava leaf meal, mineral or both showed no difference but higher than digestibility of ammoniated palm oil frond without supplement. This proved that supplementation of precursor rumen microbe nutrient could increase feed digestibility because of the increase of rumen bacteria population.

This research also showed that although supplementation of precursor nutrient of rumen microbe could increase the digestibility of dry matter and organic matter, it could not equate the digestibility of grass. The same study has been done on sheep also showed similar results [21]

IV. CONCLUSION

Supplementation of cassava leaf and mineral S and P in cattle ration based on ammoniated palm oil frond could increase bioprocess in rumen as seen from the increase of rumen bacteria population and digestibility of dry matter and organic matter. The highest bacteria population was in treatment E that provided all nutrients required for the optimum growth and activity of rumen microbe.

ACKNOWLEDGMENT

The study was supported by *Badan Penelitian dan Pengembangan Pertanian Depertemen Pertanian (Balitabang Deptan)* through funding KKP3T program year 2011. The study would not have been possible without the cooperation of laboratorium Balai Penelitian Ternak Ciawi Bogor.

REFENCES

[1] Statistic Indonesia. (2012). [Online]. Available: http://www.bps.go.id/menutab.php?tabel=1&kat=3&id_subyek=54

[2] S. A. Akbar, N. Jamarun, and R. Saladin dan Mardiati, "Effect of fermentation and defaunation on nutrient content, digestibility and rumen fluid characteristics (in-vitro) of palm empty bunches," *Jurnal Ilmiah Ilmu-ilmu Peternakan*, vol. 8, no. 2, pp. 132-144, November 2005.

[3] S. A. Akbar, "Utilization of fermented palm bunches trash combined with defaunation and rumen by pass protein on sheep performance," *Journal of the Indonesian Tropical Animal Agriculture*, vol. 32, no. 2, pp. 80-85, Juni 2007.

[4] Nurhaita, N. Jamarun, R. Saladin, L Warly, and Z. Mardiati, "The effects of processing methods for oil palm leave by product on nutritive value and in vitro digestibility," *J. Ilmu-Ilmu Pertanian Indonesia*, no. 2, pp. 139-144, December 2007.

[5] Nurhaita, N. Jamarun, R. Saladin, L. Warly, and Z. Mardiati, "The effect of sulphur and phosphorus supplementation at ammoniation palm oil leaves on in vitro digestibility and rumen liquid characteristic," *Journal of the Indonesian Tropical Animal Agriculture*, vol. 33, no. 1, pp. 51-58, March 2008.

[6] Nurhaita, N. Jamarun, L. Warly, and Z. Mardiati, " Microbial protein synthesis in cattle that received rations ammoniation palm leaf supplemented by mineral S, P and cassava leaves," *Jurnal penelitian Universitas Jambi Seri Sains*., vol. 12, no. 2, pp. 107-114, July 2010

[7] P. J. Van Soest, "Rice straw, the role of silica and treatment to improve quality," *J. Anim. Feed Sci and Technology*., vol. 130, pp. 137–171, November 2006

[8] M. Zain, Jamarun, and S. dan Nurhaita, "Fermentabilitas and in-vitro digestibility of coco dust fermented by rumen microbes," *Jurnal Ilmiah Ilmu-ilmu Peternakan*., vol. 9, no. 1, pp. 39–49 February 2006.

[9] M. Zain, N. Jamarun, and Nurhaita, "Effect of sulfur suplementation on in vitro fermentability and degradability of ammoniated rice straw," *Pakistan Journal of Nutrition*, vol. 9, no. 5, pp. 413-415, Mei 2010.

[10] S. Komisarczuk and M. Durand, "Effect of mineral on microbial metabolism," in *Rumen Microbial Metabolism and Ruminant Digestion*, J. P. Jouany, Ed., Inra Editions, Paris, 1991, pp. 179-198.

[11] D. Bravo, D. Sanvant, C. Bogaert, and F. Meschy, "Quantitative aspect of phosphorus absorbtion in ruminant," *J. Reprod Nutr. Dev*., vol. 43, no. 3, pp. 271, 284, May-June 2003.

[12] Rodehutscord, M. Heuvers, and H. Pfeffer, "Effect of organic matter digestibility on obligatory faecal phosphorus loss in lactating goats, determined from balance data," *J. Anim. Sci*., vol. 70, pp. 561 -568, 2000.

[13] J. Stevani, M. Durand, R. Zanchi, P. Beaumatin, and G. Hannequart, "Effect of sulphate supplementation of untreated and alkali treated wheat straws on ruminal fermentition and microbial protein synthesis in a semi continous fermentor," *Animal Feed Sci. and Technology*, vol. 36, pp. 287-301, March 1992.

[14] P. M. Kennedy, J. B. Lowry, and L. L. Conlan, "Phosphat rather than surfactant accounts for the main contribution to enhanced fibre digestibility resulting from treatmen with boiling neutral detergent," *J. Animal Feed Sci. and Technology*, vol. 86, pp. 177-190, August 2000.

[15] M. Zain, D. Mangunwidjaya, and Elihasridas, "Supplementation of cassava leaves to optimaze the use palm press fiber as ruminant feed," *Journal of The Indonesian Tropical Animal Agriculture*., vol. 32, no. 2, pp. 100-105, July 2007.

[16] Nurhaita, "Evaluation and utilization of palm oil leaves in ruminant rations," Disertasi Doctor Program Pascasarjana Universitas Andalas, Padang, 2008.

[17] Nurhaita and W. S. N. Rusmana, "The effect of cassava leaves supplementation at ammoniation of palm oil leaves to in vitro digestibility and rumen liquid characteristics," *Jurnal Peternakan Indonesia*, vol. 13, no. 1, pp. 43-47, February 2011.

[18] M. Zain, Elihasridas, and D. Mangunwidjaya, "Effect of supplementation of cassava leaves on digestibility and fermentabilitas (in-vitro) ammoniation palm fiber ration," *J. Andalas Sain*, vol. 15, no. 41, pp. 64-71, May 2003.

[19] R. G. Stell and J. H. Torrie, *Principles and Procedures of Statistics*, Mc. Graw-Hill Book Co. Inc. New York, 1991.

[20] National Research Council, *Nutrient Requirements of Sheep*, Sixth Revised Edition. National Academy Press, Washington, D.C. 1985

[21] Nurhaita, N. Jamarun, L. Warly, and Z . Mardiati, "Digestibility of sheep ration containing ammoniated palm oil leaves supplemented with sulphur, phospor and cassava leaves," *Jurnal Media Peternakan* (*Journal of Animal Science and Technology*), vol. 33, no. 3, pp. 144-149, December 2010.

Nurhaita was born in Bengkalis , Riau - Indonesia 15th april 1966. Finished her undergraduate study (S1) in 1990 , the Master's program in 2001, and Doctoral program in 2008. All is completed at the University of Andalas Padang, West Sumatra, Indonesia.

She worked as a lecturer at the Faculty of Agriculture University of Muhammadiyah Bengkulu since 1993 until now. Since 2011 she served as secretary of Lembaga Penelitian dan Pengabdian pada Masyarakat (LPPM), University of Muhammadiyah Bengkulu.

She has done some researches on efforts to improve the utilization of agricultural and plantation wastes for animal feed. Some of her paper has published "The Effect of Sulphur and Phosphorus Supplementation at Ammoniation Palm Oil Leaves on *In Vitro* Digestibility and Rumen Liquid Characteristic". *Journal of The Indonesian Tropical Animal Agriculture* Vol 33 No 1, March 2008; "Digestibility of Sheep Ration Containing Ammoniated Palm Oil Leaves Supplemented with Sulphur, Phospor and Cassava leaves" *Jurnal Media Peternakan* (*Journal of Animal Science and Technology*) Vol 33 No 3, Desember 2010.

She is a member of Himpunan Ilmuwan Tumbuhan Pakan Indonesia (HIPTI) since 2013 and actively participate in national research results seminars.

