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CONTENTS

ORAL PRESENTATION

Effect of Protected Vegetable Oils on In Vitro Fermentation Characteristics and Nutrient Digestibility of Bali Cattle Rumen Fluid

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ABSTRACT

In vitro experiment using rumen fluid of Bali cattle was conducted to evaluate the effect of different vegetable oils protected in calcium soap on the fermentation characteristics and nutrien digestibility. The experiment was assigned in factorial complete block design with three replications (block). The first factor was source of vegetable oil (soybean oil, palm oil, sunflower oil) and the second factor was type of protection (unprotected and calcium soap protection). The ration consisted of 60% concentrate and 40% grass. Vegetable oils were added at 5% of ration drymatter. The results showed that there was no interaction between source of oils and type of protection on all parameters, except on total volatile fatty acid (VFA). The highest VFA production was obtained from ration containing protected soybean oil compared to the other treatments. The rations containing protected vegetable oils had higher ($P<0.05$) dry matter digestibility (72.51 ± 1.66% vs 70.76 ± 1.76%), organic matter digestibility (75.58 ± 1.26% vs 74.62 ± 1.57%), and total bacterial population (7.65 ± 1.26 vs 7.16 ± 0.95 log CFU/ml) compared to those unprotected oils. However, the oils protection decreased NH_3 (5.94 ± 0.70 mM vs 7.16 ± 0.36 mM) and protozoa population (4.81 ± 0.22 log CFU/ml vs 5.11 ± 0.11 log CFU/ml). Source of oils did not significantly affect all parameters measured. It is concluded that oils protected in calcium soap improves in vitro fermentation and digestibility of Bali cattle rumen fluid, and ration containing protected soybean oil produces the highest VFA.

Key Words: Calcium soap, Vegetable oils, Rumen fluid, Bali cattle

INTRODUCTION

High saturated fatty acids content in meat is tightly related to increased risk of cardiovascular diseases and cancer if consumed excessively (Whetsel, 2003). Using vegetable oil which containing high polyunsaturated fatty acids (linolenic, linoleic and oleic acids) is proven to reduce saturated fatty acid content and increase unsaturated fatty acid content in ruminant meat products (Ludden et al., 2009). However, using vegetable oil in the ruminant ration faces two problems, first is anti-microbial effect of unsaturated fatty acid which can disturb fermentation and digestion activities in the rumen and second, biohydrogenation of unsaturated fatty acids by rumen microbes so that its efficiency decreases (Jenkins and Palmquist, 1984). Therefore the use of vegetable oil should be protected to avoid biohydrogenation process by rumen microbes so that the unsaturated fatty acid can escape rumen digestion process so it can be deposited in the meat. Furthermore, the aim of vegetable oil protection is to reduce toxicity effect of unsaturated fatty acids so that doesn't disturb the activities and reduce the growth of rumen microbes, as well as reducing feed digestibility. One of the methods to protect unsaturated fatty acids of vegetable oil from rumen digestion process is calcium soap technology (Jenkins and Palmquist, 1984).

This study was conducted to test the effectiveness of the use of calcium soaps of 3 types of vegetable oil (soybean oil, palm oil and sunflower oil) on in vitro fermentation characteristics and feed dry and organic matter digestibilities. This study was expected to produce the best oil type in terms of digestibility parameter and rumen fermentation characteristics.

MATERIALS AND METHODS

This study used three vegetable oil types as the sources of unsaturated fatty acid i.e., soybean, palm and sunflower oils. Calcium soaps were produced using the method of Kumar *et al.* (2006) starting with determining saponification number of every oil type to discover the amount of *sodium hydroxide* (NaOH) solution in the process of making calcium soaps (Apriyantono et al., 1989). The mixture of oil and NaOH solution was heated on a hotplate at *smoke point* temperature. Each oil type was stirred with stirrer until the oil dissolved perfectly. *Calcium chloride* ($CaCL_2$) as number 2.35 g solution in 4.7 ml water was added then stirred until calcium soap sedimentation occurred. Then, calcium soaps were dried in an oven at 60 °C overnight and ready to be used [7]. Dietary treatment in this study was a mixture of concentrate (60%) and grass (40%). The concentrate ingredient consisted of pollard, cassava, coconut meal, soybean meal, molasses, $CaCO_3$, urea and 5% vegetable oil calcium soap. Nutrients contents of diets were iso energy (total digestible nutrient, TDN 70%) and iso protein (crude protein, CP 15%) in accordance with the requirement of 250 kg cattle weight with 0.5 kg/day weight gain (Kearl, 1984). Experiment was arranged using factorial randomized block design to test 6 different treatment combinations. Treatment combinations consisted of two types of oil protection (without and with protection of fatty acid using calcium soap) and three vegetable oil types (soybean, palm and sunflower oils). Measured variables included rumen fermentation characteristic variables : dry matter and organic matter digestibility, pH, N-NH3, total VFA, protozoa population and total bacteria.

In vitro fermentation experiment used the in vitro method suggested by Tilley and Terry (1963). The procedure was as follows: weighing 500 mg feed sample in fermentor tube, adding 10 ml bali cattle rumen fluid and 40 ml buffer solution (Mc Doughall solution) as synthetic saliva to maintain the pH of rumen, then incubated at 39 ^{0}C for 48 hours. Rumen fluid was collected using vacuum pump and stomach tube. In order to maintain anaerobic condition, each fermentor tube was flushed with CO_2 gas. After 48 hours incubation, 2% pepsin solution as post-rumen digestive liquid was added. At this stage anaerobic condition was no longer required. Fermentor tubes were still incubated at 39 ^{0}C for another 48 hours. Fermentation residual in the fermentor tubes was filtered using whatman filter paper No.41 for further analysis of dry matter and organic matter digestibility. Measurement of total bacteria and protozoa populations used the method proposed by Ogimoto and Imai (1981). N-NH3 Analysis was conducted using Conway's micro-diffusion method (Sutardi, 1994)

RESULTS

The average of dry matter digestibility of rations containing calcium soap protected were higher than rations containing unprotected oil but no differences were found between vegetable oils.

Table 1. Dry matter digestibility (%) of rations which containing unprotected oil and calcium soap protection

Oil Source	Type of protection		Average
	Unprotected	Calcium soap protection	
Soybean oil	72.29 ± 5.31	71.09 ±7.75	71.69 ± 0.84
Palm oil	68.83 ± 5.52	74.33 ± 6.10	71.58 ± 3.89
Sunflower oil	71.16 ± 6.34	72.12 ± 2.08	71.64 ± 0.68
Average	70.76 ± 1.76^b	72.51 ± 1.66^a	

Note : Averages with different letters in the same column or line have significant difference($P<0.05$)

Table 2. Organic matter digestibility (%) of ration which contain unprotected oil and calcium soap protection

Oil source	Type of protection		Average
	Unprotected	Calcium soap protection	
Soybean oil	75.99 ± 5.01	74.56 ± 6.77	75.27±1.01
Palm oil	72.90 ± 4.73	76.99 ± 5.33	74.94±2.89
Sunflower oil	74.97 ± 5.67	75.18 ± 2.45	75.08±0.15
Average	74.62 ± 1.57[a]	75.58 ± 1.26[b]	

Note : Averages with different letters (a,b) in the same column or line have significant difference (P<0.05)

The average of organic matter digestibility of ration containing calcium soap protected oil was higher (P<0.05) that of which containing unprotected oil and no difference between oil types.

Table 3. N-NH3 Concentration (mM/ml rumen fluid)

Oil source	Type of protection		Average
	Unprotected	Calcium soap protection	
Soybean oil	7.29 ± 0.91	6.55 ± 0.82	6.92 ±0.52[a]
Palm oil	7.44 ± 0.92	6.10 ± 1.22	6.77 ±0.95[a]
Sunflower oil	6.76 ± 0.20	5.17 ± 0.41	5.96 ±1.12[b]
Average	7.16 ±0.36[a]	5.94 ±0.70[b]	

Note : Averages with different letters (a,b) in the same column or line have significant difference (P<0.05).

The average of N-NH3 concentration of ration containing unprotected oil was lower than calcium soap protected oil. Similarly N-NH3 content of soybean oil tended to be higher than other oil types.

Table 4. Protozoa population (log10/ml rumen fluid)

Oil source	Type of protection		Average
	Unprotected	Calcium soap protection	
Soybean oil	5.13 ± 0.07	4.96 ± 0.09	5.05± 0.13
Palm oil	5.01± 0.22	4.56 ± 0.40	4.79 ±0.32
Sunflower oil	5.22 ± 0.11	4.92 ± 0.30	5.07 ±0.21
Average	5.11 ± 0.11[b]	4.81 ± 0.22[a]	

Note : Averages with different letters in the same column or line have significant difference(P<0.05)

The average of Protozoa population of ration containing vegetable oil calcium soap was lower than unprotected oil and there was no difference in protozoa population between oil types.

Table 5. Total bacterial population (log10CFU/ml rumen fluid)

Oil source	Type of protection		Average
	Unprotected	Calcium soap protection	
Soybean oil	6.45 ± 170	8.24 ± 1.70	7.35 ± 1.26
Palm oil	6.78 ± 1.36	8.52 ± 0.69	7.65 ± 1.23
Sunflower oil	8.24 ± 0.50	6.20 ± 2.32	7.22 ± 1.44
Average	7.16 ± 0.95[b]	7.65 ± 1.26[a]	

Note : Averages with different letters in the same column and line have significant difference(P<0.05)

The average of total bacterial population of calcium soap protected oil was higher than unprotected oil and there was no difference in bacteria population between oil types.

Table 6. Total VFA content (mM/ml rumen fluid)

Oil Type	Type of protection		Average
	Unprotected	Calcium soap protection	
Soybean oil	184,22 ± 68.94	*181,04 ± 41.98*	182,63 ± 2.25[a]
Palm oil	167,63 ± 49.04	180,54± 67.09	174,09 ± 9.13[a]
Sunflower oil	145,45 ± 16.91	169,28 ± 48.15	157,36 ± 16.85[b]
Average	165,77 ± 19.45[b]	176,95 ± 6.65[a]	

Note : Averages with different letters n the same column and line have significant difference($P<0.05$)

Total VFA content in ration ed calcium soap protected oil was higher than unprotected oil. The use of soybean oil tended to produce higher total VFA content than other oil types.

DISCUSSION

Based on data of variables observed in this study, protection of oil by calcium soap produced better rumen fermentation characteristics than the unprotected oil treatment. This means that protection technique using calcium soap could reduce the negative effects of polyunsaturated fatty acid on the growth and activity of bacteria so that fermentation process inside rumen could be optimised. Decrease in protozoa population ($P<0.05$) was expected because protozoa's ability in performing fat biohydrogenation process is lower than that of bacteria, so that the accumulation of fat in the feed decreased the growth. Decrease in $N\text{-}NH_3$ content in diet containing calcium soap protected oil was suspected to be caused by utilization of N-NH3 in the fermentation process for microbial in cell synthetic process and microbial activities. This was shown in dry matter digestibility and organic matter digestibility of feed and total VFA content obtained during fermentation process of ration containing calcium soap were higher than unprotected vegetable oil.

REFERENCES

Apriyantono, A. Fardiaz, D., Pupitasari, N.L., Sedernawati, Budiyanto, S. 1989. Analisis Pangan. Depertemen Pendidikan dan Kebudayaan, Direktorat Jenderal Pendidikan Tinggi. Pusat Antar Universitas Pangan dan Gizi, Intitut Pertanian Bogor.

Duckett, S.K. and Gillis, M.H. 2010. Effects of oil source and fish oil addition on ruminal biohydrogenation of fatty acids and conjugated linoleic acid formation in beef steers fed finishing diets. J. Anim. Sci. 88: 2684-269.

Ogimoto, K., and Imai, S., 1981. Atlas of Rumen Microbiology. Japan Scientific Societies Press. Tokyo. Japan

Kearl, C.L. (1984). Nutrient Requirements of Ruminants in Developing Countries. Internasional Feedstuffs Institute. Utah Agricultural Experiment Station, Utah State University, Logan Utah.

Kumar, D.K.Sivaiah, Y.Ramana Reddy, B.Ekamram. T.J. Reddy. And G.V.N. Reddy. 2006. Effect of supplementation of dietary protected lipids on intake and nutrient utilization Deccani lambs. J.Tropical Anim. Health. Prod.38: 151-158.

Ludden, P.A., Kucuk, O., Rule, D.C., Hess, B.W., 2009. Growth and carcass fatty acid composition of beef steers fed soybean oil for increasing duration before slaughter. J.Meat. Sci. 82 : 185-192

Sutardi, T. 1994. Peningkatan produksi ternak ruminansia melalui amoniasi pakan serat bermutu rendah, defaunasi dan suplementasi sumber protein tahan degradasi dalam rumen. Laporan Penelitian Hibah Bersaing 1993/1994. Institut Pertanian Bogor.

Tilley, J.M.A. and R.A.Terry. 1963. A two-stage technique for in vitro digestion of forage crops. J. Brit.Grassland Soc. 18:104.

Whetsel, S.M. 2003. Human healt effects of fatty acids in beef. Pasture-based beef systems for appalachia. Extension Service. West Virginia University.