Concentration of Short Chain Fatty Acid and Methane Gas of Ration Containing Different Level of Oil Palm Decanter Meal: *In vitro* Study

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ABSTRACT

The aim of this study was to reveal the differences of concentration of short chain fatty acid (SCFA) and methane gas production from ration containing different level of oil palm decanter meal (OPDM). Four treatment rations namely P_0, P_1, P_2 and P_4 were formulated to contain forage, OPDM and concentrate. *In vitro* technique was applied for measuring SCFA and methane production. Production of SCFA including acetate, propionate, butyrate and the ratio of acetic, propionic acid and methane gas was significantly P<0.05) different among treatments. It could be concluded that OPDM in ration was suitable for dairy ruminant but it was not recommended for meat.

Key words: Decanter meal, Fatty acid, Methane, Oil palm, Ration.

Oil palm decanter meal is one of an important by-product generated from palm oil plant especially in the country producing palm oil until now. Actually OPDM is principally obtained from dehydrating of palm oil mill effluent after processing though decanter machine. This by-product is considerably good potential as ruminant feed due to it availability and nutritional composition. In fact, using OPDM as a ration component has been applied to some livestock like lambs, goat and cow, with different results. Nutritionally, OPDM contains high in crude fibre composition of 73.33 - 76.84% of NDF and also high in mineral content especially Fe (Afdal *et al*., 2012). Fibre content is an important factor in ration of ruminant and would also influence the digestion process in rumen. It is crucial to sustain animal health and proper rumen function and physiology (Chacko Biju *et al*., 2018).

To optimize the utilization of OPDM in ration, it is required to formulate a good proportion of OPDM in ration in order to meet nutrient and energy requirement for ruminant. The readiness of nutrient and energy in ration for ruminant and microbial liability in rumen can be evaluated through fermentation activity. The main end product of fermentation in rumen normally includes SCFA mainly acetate, propionate and butyrate as well as carbon dioxide, methane and ammonia. Alhidary *et al.* (2024) added that the fermentation in the rumen are characterized by pH, ammonia-nitrogen, gas production, volatile fatty acids, bacterial quantification and indices of rumen morphology.

However, as far as our knowledge, there is no study regarding to the picture of different level of OPDM in ration on the fermentation in rumen. Therefore, the aim of this study was to reveal the effect of level of OPDM on rumen fermentation including SCFA concentration and methane gas production through *in vitro* method.

This present study was carried out at the Laboratory of Animal Nutrition, Faculty of Animal Husbandry, Univeritas Jambi from 1st August to 30th September 2022 and the analysis of SCFA was done at Institute of Animal Research, Ciawi Bogor Indonesia. Four experimental rations namely P_0, P_1, P_2 and P_3 were formulated to contain forage, OPDM and rice bran as concentrate with the chemical ingredient as in Table 1. Each ration was dried in an oven at 60°C for 24 hours, ground through a 2 mm sieve and stored until used.

This experiment was done with *in vitro* procedure (Tilley and Terry, 1963) Filtered rumen fluid was collected and mixed with buffer solution in ratio of 1:4 for rumen fluid and buffer solution. Fifty millilitres of this mixture was transferred into a serum bottle (100 ml capacity) containing 1 g of feed sample according the treatment. The bottle was sealed with rubber stopper and incubated for 72 h at 39°C. The incubated inoculum was sampled for analysis of SCFA) including acetate, propionate butyrate, total SCFA and methane. SCFA concentrations were determined using Gas Chromatography (Shimadzu

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GC-14A). Methane concentration was determined following procedure (Fievez *et al*., 2005).

For this experiment, completely randomized design was applied with four treatments including P_0, P_1, P_2 and P_3 and four replications. The effect of level of OPDM on the SCFA and methane gas concentration was analysed using one-way analysis of variance (ANOVA), followed by Duncan's range test, using the SAS software (SAS Institute Inc., Railg, North Carolina, 2002).

Fatty acid production

The molar proportion of acetate, propionate and butyrate as well as total SCFA concentration and methane in ration containing different level of OPDM are presented in Table 2.

Production of SCFA including acetate, propionate, butyrate and the ratio of acetic and propionic acid was significantly P<0.05) different among treatment and the production of methane (CH4) was also significantly (P<0.05) (Table 2).

The increase of OPDM in ration would increase the production of the volatile fatty acids as a source of energy for the ruminant. The percentage of acetic acid significantly increases from treatment of 18 to 36% of OPDM and then decrease until these of 72%. On the other hand, for Propionic and Butyric acids, it significantly decreases at 36% of OPDM and then increase until these of 72% of OPDM. The treatment of 36% of OPDM was interesting in this experiment. The concentration of acetate, propionate and butyrate is affected by ration composition (Palmonari *et al*., 2023) as well as the availability of nutrient and then the presence of rumen microbe. Bhat *et al*. (2018) added that total of SCFA significant escalate the in-vitro digestibility. In this experiment, all of result of this molar percentage of SCFA acetic, propionic and butyric acid was still in normal condition. The acetic acid concentration was higher than those results reported by (Manpreet *et al*., 2022) and it was 62.60-64.10% mol, more or less the same than result reported Beckett *et al*. (2021). The propionic acid concentration was little bit higher than those results reported by Beckett *et al*. (2021) but it was little bit lower than those studied by (Manpreet *et al*., 2022). The interesting in this study looks the higher the level of OPDM in the ration, the higher the concentration of acetic acid, the lower the concentration of propionate and the higher the concentration of butyric acid in rumen. The increase level of OPDM would increase acetic acid that is suitable for formation of milk fat. However, it might not good for growing ruminant as decreasing of propionic acid that plays an important role in gluconeogenesis for growing animal.

Table 1: Feed and chemical composition of experimental ration.

	P_0	P_1	P_2	P_3
Feed composition				
Forage (%)	72	54	36	18
OPDM (%)	18	36	54	72
Rice bran (%)	10	10	10	10
Chemical composition				
Crude protein	12.95	12.77	12.59	12.41
Crude fibre	32.1	28.7	25.3	18.5
Ash	11.82	11.28	10.74	10.2
Fat	3.912	5.992	8.072	10.152
TDN	57.3	55.9	54.5	53.1

Ratio of acetic: Propionic acid

The ratio of acetic and propionic acid was significantly P<0.05) different among treatments (Table 2). It looks the increase of AP ratio with the increase of level OPDM in ration. This might be due to the increase of OPDM level in the ration. This ratio was still below those results of Javanese bull (3.77) and Ongole cross bull (4.44) in Java studied by Purbowati *et al*. (2014). This result of this present study was higher than those stated by (Manpreet *et al*., 2022) The decrease of the ratio of AP would effect on the increase of weight gain. The increase level of OPDM in ration looks increase of the ratio of Acetic and Propionic. The increase level of OPDM could be suitable for dairy as it could increase increases milk fat synthesis, making it important for dairy cows.

Methane production

The production of CH4 was significantly (P<0.05) among the treatments. The increase level of OPDM would decrease the production of methane. This might be due to the increase of fat content of OPDM that decrease of methane gas production. Rathod *et al*. (2024) reported in their respiration chamber study that the methane production from calf significantly decrease after being fed with the unconventional oil cake. The decrease of methane production might be also due to the effect of increase production of acetic acids. In formation of acetic acid, it would consume

Table 2: The molar proportion of SCFA and methane gas.

Parameter	Treatment			
	P_0	P_1	P_2	P_3
Acetate (%)	64.22 ± 1.19^{b}	67.39±0.59^{a}	65.85±0.35^{ab}	66.04±0.53^{ab}
Propionate (%)	26.50 ± 0 .98^{a}	23.88±0.32^{b}	24.51±0.25^{b}	24.39±0.22^{b}
Butyrate (%)	7.05 ± 0.15^{ab}	6.67±0.19^{b}	7.37±0.10^{a}	7.23±0.25^{ab}
Ratio A:P	2.44±0.24^{b}	2.83±0.11^{a}	2.69±0.07^{ab}	2.71±0.08^{ab}
CH4 (%)	21.88 ± 0.37^{a}	19.80±2.05^{ab}	16.50±0.50^{ab}	16.00±1.04^{b}

^{a,b} different superscript within the same row is significantly different (P<0.05).

hydrogen ion that reduces or disturbs archaea methanogenic population in methanogens that reduce methane production. Methane is a potent greenhouse gas from enteric fermentation from rumen (Broucek, 2014). This indicates that using OPDM in ration would reduce the greenhouse gas from anthropogenic emissions of methane.

CONCLUSSION

It could be concluded that OPDM in ration was suitable for dairy ruminant due to it increased the production of acetic acids that influence on the quality and quantity of milk. However, OPDM was not recommended for beef ruminant animal as it decreased the production of propionic acids that it is a major precursor in gluconeogenesis in the liver, which is essential for muscle growth.

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Disclaimers

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Informed consent

All animal procedures for experiments were approved by the Committee of Experimental Animal Universitas Jambi.

Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this article. No funding or sponsorship influenced the design of the study, data collection, analysis, decision to publish, or preparation of the manuscript.

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