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Effect of Mineral Mix Supplementation in Silage of Palm Frond Grated (PFG) and Palm Sludge on Digestibility and Delay Quality By In Vitro Methods

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ABSTRACT

By-products from oil palm can feed ruminants such as palm fronds (OPF) and palm oil sludge (PS). Judging from its continuous, cheap, and abundant availability from the palm oil industry, as well as a source of fiber or a component in complete feed for ruminants, it is the potential that can be used as animal feed. However, the use of oil palm fronds in livestock production is minimal due to their complex fiber structure, high lignin content, and low protein content. So, it needs management technology on OPF. The design used was a Completely Randomized Design (CRD) with three treatments and five repetitions: P0 Palm frond silage (30%) + palm sludge (70%) P1 Silage of palm fronds (30%) + palm sludge (70%) + Mineral Mix 1% P2Palm frond silage (30%) + palm sludge (70%) + Mineral Mix 2%. The data obtained were analyzed for variance according to the design used, and if there were differences between the treatments, continued analysis using the Duncan Multi Range Test Based on the results of statistical analysis showed that the silage treatment of palm frond powder and palm sludge supplemented with a mineral mix in vitro decreased the digestibility value of dry matter ($P<0.05$). However, different results were shown in the digestibility of organic matter, where increased digestibility occurred in treatment with supplementation of mineral mixes. The statistical analysis showed that the silage treatment of palm frond powder and palm sludge supplemented with the mineral mix in vitro showed no significant difference between treatments ($P>0.05$) on VFA and NH_3 values. Based on the study's results, it can be concluded that mineral mix supplementation in the silage of palm frond powder and palm sludge significantly decreases the digestibility of dry matter but increases the digestibility value of organic matter. Nevertheless, the treatment did not significantly affect the quality of the fermentation, which included VFA and NH3.

Keywords: mineral mix, palm fronds grated, palm sludge oil

INTRODUCTION

Indonesia is the largest palm oil-producing country in the world. The area of oil palm plantations in Indonesia in 2021 is 15,081,021 Ha, and for the province of South Sumatra in 2021, around 1,215,476 Ha (Ditjenbun, 2021). By-products from oil palm can be used as feed for ruminants such as palm fronds (OPF) and palm oil sludge (PS) (Winarna et al., 2014). Judging from its continuous, cheap, and abundant availability from the palm oil industry, as well as a source of fiber or a component in complete feed for ruminants, it is the potential that can be used as animal feed. However, the use of oil palm fronds in livestock production is minimal due to their complex fiber structure, high lignin content, and low protein content. So it needs management technology on OPF.

Silage is a form of forage preservation. The principle of making silage is to stop contact between forage and oxygen so that lactic acid bacteria can grow in anaerobic conditions by converting soluble carbohydrates into lactic acid easily. The silage process with the addition of salt can improve digestibility and extend shelf life. The addition of 1-3% salt is essentially non-organizing. According to Viander et al. (2003), Low salt concentrations can help bacterial growth by increasing the growth of lactic acid bacteria in the fermentation process so that acidic conditions are achieved. Spoilage bacteria become inhibited and do not develop.

Palm Oil Sludge (PS) is palm oil processing waste produced by squeezing palm fruit. PS is a potential resource as animal feed, cheap, available in large quantities, and relatively available all the time. The use of palm fronds and palm oil sludge as livestock feed is still minimal because palm fronds contain high lignin, which causes low digestibility. In addition, the high content of crude fiber and fat is an obstacle to using PS as ruminant feed. PS in the new form will not last long and spoil quickly. It is necessary to manage the PS to be carried out. Processing is expected to break down the bonds of lignin, cellulose, and hemicellulose to increase the digestibility of the material and increase the nutritional value for the better.

Palm oil sludge contains unsaturated fatty acids, which may positively affect livestock performance. However, excessive use of fat above

5% of the total ration in ruminant feeds can cause adverse effects affecting the physical form of the feed and rumen microbes (Austin et al., 2016; Jenkins, 1993). Yao KY et al. (2018) reported that the fat content in PS can inhibit microbial activity during rumen fermentation, inhibiting digestibility. Constraints to using PS as animal feed cannot be used as a single feed, so it must be accompanied by adding other supplements. Febrina et al. (2017) reported that the minerals Calcium (Ca) and Manganese (Mn) are examples of mixed minerals with a combination of micro and macro minerals that function as growth and development stimulants for microorganisms that act as degraders of lignin levels contained in forage livestock feed. Mineral Mix supplementation in PS is expected to increase metabolic activity and activate enzymes involved in fermented feed. Based on the description above, research will be carried out regarding the quality of grated palm fronds and palm oil sludge with the mineral mix *in vitro*.

MATERIALS AND METHODS

Sample Preparation

Phase I: Palm Frond Grated (PFG) Silage Process

Preparing the tools and materials to be used, namely the palm fronds, the fronds of palm fronds are peeled first; after peeling then, the fronds are soaked with a saltwater solution of 1-3% from 20 litres of water for 6 minutes. The soaked palm fronds are removed and drained, then grated until 3 kg is produced. The shredded palm fronds are then put into plastic bags anaerobically for the silage process. After 24 hours, the fermentation process in the midrib begins to occur and produces gas. The gas produced is released through holes in the plastic at several points using a syringe. The sample is left for one week until the gas is ultimately used up.

Phase II: Palm Frond Vacuum Process

The fermented palm fronds are put into a plastic bag, then the bag filled with fermented palm fronds is sprinkled with B complex, and then the sample is vacuumed until anaerobic.

Phase III: Processing of Palm Mud

Palm mud is taken from PT. Golden Oilindo Nusantara (GON) was prepared in as much as 5 kg. The next step is to place the palm sludge on a stencil tray, weigh it, and put it in the oven at 60ºC for 24 hours. Palm sludge was weighed and re-heated at 105ºC for 1 hour to obtain a constant weight. Palm mud that has been dried, then mashed into flour. After becoming palm mud flour, the flour is ready for further processing.

Phase IV: Mixing of Palm Frond Silage, Palm Mud, and Mineral Mix

Samples of palm frond silage that have been fermented, then sprinkled with mineral mix with a percentage of 1% and 2%, respectively. After mixing is complete, then to the frond sample that has been sprinkled with vitamins is added back to the palm mud, which has become flour with a ratio of 30% (palm frond silage and Mineral mix): 70% (palm mud flour) and then the sample is ready for the analysis process. The chemical composition of palm fronds Grated (PFG) and Palm Sludge (PS) are presented in Table 1.

Table 1. Chemical composition of palm fronds Grated (PFG) and Palm Sludge (PS)

Variable	PFG Con	PS
DM % as fed	81.07	90.00
CP, % of DM	7.41	9.6 -15.52
CF, % of DM	52.45	11.5 -32.9
NDF, % of DM	39.19	-
ADF, % of DM	8.91	-
Hemicellulose	30.28	-
Cellulose	7.47	-

PFG (palm fronds Grated); PS (Palm Sludge); DM, dry matter; CP, crude protein; EE, ether extract; CF, crude fiber; NDF, Neutral Detergent Fiber; ADF, Acid Detergent Fiber.

Research Methods

The study was conducted *in vitro* using an experimental method. The design used was a Completely Randomized Design (CRD) with three treatments and five repetitions: P0 = Palm Frond Grated (30%) + palm sludge (70%); P1 = Palm Frond Grated (30%) + palm sludge (70%) + Mineral Mix 1%; P2= Palm Frond Grated (30%) + palm sludge (70%) + Mineral Mix 2%. The powdered sample is then put into a plastic zip-lock

and brought to the laboratory for analysis. Samples in the form of flour are intended to make it easier for homogeneous samples when mixed with rumen fluid. After the sample preparation is complete, it will be followed by a digestibility test using the *in vitro* method (Tilley and Terry, 1963).

Data Analysis

The data obtained were analyzed for variance according to the design used, and if there were differences between the treatments, continued the Duncan Multi Range Test (DNMRT) (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

Digestibility of Dry Matter and Organic Matter

The statistical analysis showed that the silage treatment of palm frond powder and palm sludge supplemented with the mineral mix in vitro decreased the digestibility value of dry matter ($P<0.05$). However, different results were shown in the digestibility of organic matter, where increased digestibility occurred in treatment with mineral supplementation.

The decrease is due to the high fat and water content in the palm frond powder and mud. The results showed that the feed ingredients' high water/fat content could affect the dry matter's digestibility. The study's results revealed that the administration of palm oil could affect the digestibility value of dry matter and organic matter by 10% (Fiorentini et al., 2015). Furthermore, Firsoni et al. (2014) reported that the high-fat content in feed ingredients affected conditions in the rumen (pH), adversely affecting feed degradation by microbes in the rumen. Furthermore, due to the high crude fiber contained in the feed ingredients, the digestibility of dry matter decreases.

This statement aligns with Miguel et al. (2021), who reported that the more crude fiber contained in a feed ingredient, the thicker the cell wall so that the coarse fiber is difficult to decompose, resulting in low digestibility in a feed ingredient. However, the results of testing the data using a meta-analysis reported no relationship/correlation between the supplementation of minerals and concentration on the digestibility of dry matter in Bali cattle and the pasture rearing system (de Almeida et al., 2022).

On the other hand, an increase in the digestibility value of the organic matter in the treated feed is thought to be due to adding mineral mix, which increases nutrient metabolism in the fermentation process. because the mineral mix is an inorganic compound that acts as a catalyst capable of decomposing organic compounds contained in the feed resulting in increased digestibility of organic matter in frond silage powder and palm sludge. In addition, the mineral mix acts as an enzyme activation that helps enzymes decompose organic compounds.

Rostini et al. (2019) reported that providing zinc (Zn) minerals to feed ingredients can increase the digestibility of organic matter because mineral supplementation is needed in the enzyme work process, where minerals act as catalysts in the enzyme work process. This statement aligns with the results of research by Hartono et al. (2015), who reported the factors affecting the digestibility of organic matter, namely crude fiber and minerals derived from feed ingredients consisting of inorganic and organic materials.

The concentration of VFA and NH_3 Values

The statistical analysis showed that the silage treatment of palm frond powder and palm sludge supplemented with the mineral mix *in vitro* showed no significant difference between treatments ($P>0.05$) on VFA and NH_3 values (Table 2). The resulting VFA value is lower when compared to testing on a combination of forage and oil palm sludge (Liman et al., 2010; Miguel et al., 2021).

Table 2. Dry Matter Digestibility (DMD), VFA, and N-ammonia (NH_3) of feed silage of palm frond Grated and palm sludge supplemented by a mineral mix

Parameters	Treatment		
	P0	P1	P2
Dry matters digestibility (%)	$44.39^{b} \pm 4.69$	$27.40^{a} \pm 2.35$	$33.80^{a} \pm 4.04$
Organic matters digestibility (%)	$49.09^{a} \pm 3.6$	$62.44^{b} \pm 2.92$	$64.95^{b} \pm 3.10$
Volatile Fatty Acid (mM)	25.71±1,45	28.03±1,08	24.90±2.03
N-NH_3 (mM)	20.56 ±3,16	18.05±0,78	18.27 ±0.61

P0 = Palm Frond Grated (30%) + palm sludge (70%); P1 = Palm Frond Grated (30%) + palm sludge (70%) + Mineral Mix 1%; P2= Palm Frond Grated (30%) + palm sludge (70%) + Mineral Mix 2%.

The low value produced can be caused by several factors, including because the mineral mix, which acts as a precursor, cannot significantly stimulate microbial activity in the rumen, so the formation of VFA in the rumen becomes very low. In addition, the high presence of lipid compounds in palm oil sludge increased fat content in the rumen, which impacted the reducing microorganisms in the rumen. This statement refers to the results of research conducted by Ibrahim et al. (2021), who stated that in ruminants, the fat content in the feed is recommended not to exceed 5% because the high-fat content will affect rumen microbial activity, namely reducing the population of fiber digestion microbes.

Furthermore, the same assumption also occurs when observing the value of NH3 in the rumen, where the role of the mineral mix cannot be active due to the high content of lipid compounds in the rumen. The results of the study revealed that the lipid content in animal feed could cause slow microbial growth because lipid compounds prevent microbes in the rumen from developing due to the physical association of lipids with the surface of feed particles (Fiorentini et al., 2015; Ibrahim et al., 2021; Jenkins, 1993). The slow development of microbes will undoubtedly affect the value of NH_3 produced because the concentration of NH_3 is strongly influenced by the levels of crude protein fermented by microbes in the rumen.

CONCLUSION

Based on the results of the study, it can be concluded that mineral mix supplementation in the silage of palm frond powder and palm sludge significantly decreases the digestibility of dry matter but increases the digestibility value of organic matter. Nevertheless, the treatment did not significantly affect the quality of the fermentation, which included VFA and NH_3.

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