



# The Effect of Addition of Fermented Oil Palm Fronds Extract on Rumen Fermentation and Blood Metabolites of Kacang Goat

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**Abstract** | This research aims to determine the effect of the addition of Fermented Oil Palm Fronds (FOPFE) on rumen fermentation and blood metabolites of Kacang goat. The fronds of palm oil were fermented for 21 days with the addition of 10% poultry manure, then extracted with methanol solvent. This study used 12 male Kacang goats aged >1 year that were placed in metabolic cages which were equipped with feedbox and water drinker. The study used a random group design, with 4 treatment groups namely P0=complete ration+ 0% FOPFE; P1=complete ration + 0.1% FOPFE; P2=complete ration + 0.2% FOPFE; P3= complete ration + 0.3% FOPFE. The measured variables were rumen fermentation indicators (pH, total VFA and ammonia (NH<sub>3</sub>)) and blood structural and metabolic components (erythrocytes, hemoglobin, hematocrit, cholesterol, urea and blood glucose). The results showed that FOPFE had no significant effect (P>0.05) on rumen fermentation and blood profile except blood cholesterol level that was significantly (P<0.01) reduced in P2 group. The administration of 0.2% FOPFE can reduce blood cholesterol levels and maintain rumen fermentation and blood metabolites of Kacang goat.

**Keywords** | Fermented oil palm fronds extract, Rumen fermentation, Blood metabolites, Goats

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## INTRODUCTION

Oil palm fronds are useful as feed, anti-microbial and antioxidant (Febrina et al., 2017; Febrina et al., 2018; Imsya et al., 2013). There is limitations on the use of oil palm fronds as feed because of the high content of lignin that is 30.18% (Febrina et al., 2016a, b). However, various treatments like physical, chemical, biological and combination treatments can reduce lignin content. The addition of 10% of poultry manure to the fermentation of oil palm fronds produced the lowest lignin content of 19.94% (Febrina et al., 2020).

One of the antinutrient compounds in oil palm fronds is tannin which has a phenol group and is colloidal; in the

rumen it forms complex bonds with carbohydrates (hemicellulose, pectin and cellulose), proteins, vitamins, minerals and enzymes (Widyobroto et al., 2007); and serves as a defaunation agent to press the methane gas emissions (Makkar, 2003). Tannins can be classified as hydrolyzed tannins and condensed tannins (Patra and Saxena, 2010) which binds to proteins and form the binding hydrogen with phenol groups and affect the protein digestibility (Mueller, 2006). Condensed tannins have lower toxic effects compared to hydrolyzed tannins (Beauchemin et al., 2008).

Ethanol extract of oil palm fronds contains mixtures of tannin and steroid (Febrina et al., 2018). Methanol extract from oil palm fronds which fermented with poultry ma-

nure contains tannin, steroid and phenolic (Febrina et al., 2020) and can be utilized as natural antimicrobials. Tannins can bind proteins (Santoso et al., 2011) and reduce palatability (Silanikove et al., 2001), however these could be beneficial for ruminants if used in appropriate dosage (Jayanegara et al., 2011; Deaville et al., 2010). The small amounts of tannin do not affect the patterns of rumen fermentation (Sunarjoko, 2015) and total VFA (volatile fatty acids) (Kondo et al., 2007); however a direct injection of tannins into the rumen affect the digestive system of sheep (Frutos et al., 2004).

Research on the effect of tannin on livestock digestive system has been reported by several researchers, but the information about the effect of tannin found in fermented palm frond extracts on rumen fermentation and blood metabolites of Kacang goat has not been reported. Therefore this study aims to determine the effects of fermented palm fronds extract added to the ration on rumen fermentation and blood metabolites of Kacang Goat.

## MATERIALS AND METHODS

### ANIMAL AND FEED

The ration consisted of fermented oil palm fronds, rice bran and tofu waste with an amount of 4% of body weight, in the form of dry matter (NRC, 1981). Drinking water is given as *ad libitum* and the ratio of concentrate and forage is 60: 40. Oil palm fronds are fermented with poultry manure for 21 days and extracted with methanol (Febrina et al., 2020). The treatment was the addition of Fermented Oil Palm Fronds Extract (FOPFE) in the ration with different doses viz., 0%; 0.1%; 0.2% and 0.3%. The doses were adopted with some modification from the study of Sujarnoko, (2015).

This research used 12 male goats aged  $\pm$  1 year with an initial body weight of  $13.1 \pm 1.1$  kg, placed in a metabolic cage equipped with feedbox and drinker. Rations were given twice a day at 08.00 AM and 16.00 PM, FOPFE is given 2 hours after feeding.

The study was conducted at the UARDS research of the Faculty of Agriculture and Animal Science, State Islamic University of Sultan Syarif Kasim Riau. This research was conducted based on ethical clearance by Faculty of Medicine of Riau University-Indonesia (No:274/UN.19.5.1.1.8/UEPKK/2018).

The analysis of rumen fermentation (pH, VFA and  $\text{NH}_3$ ) was carried out at the Animal Research Institute (Balitnak) Bogor Indonesia and analysis of blood cells/metabolites were done at the Veterinary Institute, Bukittinggi Indonesia. The composition of ration and nutritional content

of ration is presented in Table 1.

### EXPERIMENTAL DESIGN AND DATA COLLECTION

The study used a random group design, 4 treatments (3 animals/group). The treatment groups were consist of P0: complete ration + 0% FOPFE; P1: complete ration + FOPFE 0.1%; P2: complete rations + FOPFE 0.2% and P3: complete rations + FOPFE 0.3%. Parameters measured includes rumen fermentation (pH, VFA and  $\text{NH}_3$ ) and blood cells/metabolites (erythrocytes, hemoglobin, hematocrit, cholesterol, blood urea and glucose).

This study consisted of an adaptation phase of one month and data collection for 28 days. Intake of rumen fluid is carried out on the 28th day of the collection period. Rumen fluid is taken after 4 hours of morning feeding (12.00 AM) by inserting a plastic hose into the mouth of the animal until it reaches the rumen, then the rumen fluid is aspirated using a syringe and then inserted into a tube. The pH of the rumen fluid is measured with a pH meter just after sampling. VFA analysis was performed by gas chromatography techniques and rumen fluid  $\text{NH}_3$  levels using the Conway method (General Laboratory Procedures, 1966).

Blood samples were taken on the 29th day of the collection period. Blood collection is carried out in the morning before feeding. Blood is drawn through the jugular vein in the neck using a 5 mL syringe and then inserted into a tube that already contains EDTA anticoagulants. Blood is put into the coolbox and taken to the laboratory for blood metabolite analysis.

### STATISTICAL ANALYSIS

The data were processed according to the analysis of the diversity of the Randomized Group Design (RBD) according to Steel and Torrie (2002). If the results of the analysis of variance indicate real effect, further tests were conducted with Duncan's Multiple Range Test (DMRT).

## RESULTS

### RUMEN FERMENTATION

The addition of FOPFE 0-0.3% in the ration did not affect ( $P > 0.05$ ) on rumen fermentation (pH, VFA and  $\text{NH}_3$ ). The pH, VFA and  $\text{NH}_3$  values of this study are within normal values to support rumen microbial growth, as shown in Table 2.

### BLOOD METABOLITES

Table 3 shows that addition of FOPFE 0-0.3% in the ration did not affect ( $P > 0.05$ ) on the levels of erythrocytes, hematocrit, hemoglobin, urea and glucose, but significantly ( $P < 0.05$ ) reduced blood cholesterol levels. Addition of

0.1% FOPFE in the ration (P1), significantly ( $P < 0.05$ ) in

**Table 1:** The composition of ration and nutritional content of ration

Composition of ration	Composition	Dry matter	Crude Protein	Crude Fiber	TDN*
	%				
Fermented Oil Palm Frond	40.00	91.29	6.63	28.71	62.56
Tofu Waste	35.00	28.40	19.08	19.80	73.21
Rice Bran	24.00	90.24	7.28	19.80	74.38
Salt	1.00	-	-	-	-
Complete ration	100.00	68.11	11.08	23.17	68.50

\* TDN: Total Digestible Nutrient

**Table 2:** Rumen Fermentation pattern of Kacang goats fed fermented oil palm fronds (FOPFE).

Sr.No.	Rumen Fermentation	Treatment				
		P0 (CR+ FOPFE)	0%	P1 (CR+ 0.1% FOPFE)	P2 (CR+ 0.2% FOPFE)	P3 (CR+ 0.3% FOPFE)
1	pH	7.95±0.53		7.92±0.49	7.88±0.17	7.74±0.63
2	VFA Total (mM)	49.04±28.07		37.13±12.17	45.57±15.48	53.95±20.90
	C2 (acetat)	20.33±10.27		17.45±6.39	20.45±7.67	23.65±8.87
	C3 (propionat)	12.50±9.85		8.17±5.06	10.46±4.67	12.79±5.73
	C4 (butirat)	9.74±7.71		8.13±5.65	9.18±3.95	10.59±6.04
3	NH <sub>3</sub> (mM)	5.60 ±0.30		4.01±0.82	3.77±0.07	4.67±0.88

CR: Complete ration; FOPFE: Fermented Oil Palm Fronds Extract; VFA : Volatile Fatty Acid; NH<sub>3</sub> : Ammonia

**Table 3:** Blood profile of Kacang goats fed fermented oil palm fronds (FOPFE).

No	Blood component	Treatment			
		P0 (CR+ 0% FOPFE)	P1 (CR+ 0.1% FOPFE)	P2 (CR+ 0.2% FOPFE)	P3 (CR+ 0.3% FOPFE)
1	Erythrocytes (mg/dL)	12.79 ± 1.00	10.62 ± 1.20	11.84 ± 0.59	12.45 ± 1.76
2	Hematocrit (%)	23.63 ± 0.65	20.03 ± 1.96	21.50 ± 0.88	23.20 ± 2.35
3	Hemoglobin (g/dL)	8.70 ± 0.21	7.83 ± 0.24	7.93 ± 0.28	8.67 ± 0.82
4	Urea (mg/dL)	39.60 ± 2.08	32.13 ± 1.14	38.33 ± 3.16	39.07 ± 3.63
5	Cholesterol (mg/dL)	79.67 <sup>a</sup> ± 3.85	101.00 <sup>b</sup> ± 11.57	83.33 <sup>a</sup> ± 6.84	74.33 <sup>a</sup> ± 3.29
6	Glucose (mg/dL)	57.00 ± 1.63	56.33 ± 6.59	50.33 ± 2.35	57.33 ± 2.62

CR: Complete ration; FOPFE: Fermented Oil Palm

### FRONDS EXTRACT

creased cholesterol levels compared without FOPFE (P0) but increased FOPFE dose from 0.1% to 0.2% (P2) and 0.3% (P3), significantly ( $P < 0.05$ ) reduced goat cholesterol levels. The administration of 0.2% and 0.3% of FOPFE (P2 and P3) exhibited a significant ( $P < 0.05$ ) reduction in the cholesterol levels as compared to treatment P1. In treatment P0, P1 and P3, cholesterol levels were not different ( $P > 0.05$ ), but significantly ( $P < 0.05$ ) lower than treatment P1.

### DISCUSSION

The pH score of this study was 7.74–8.15 (Table 2). Similar results were reported by Umar et al (2011), giving rations containing 30% elephants grass and 70% concen-

trates in Madura cows and Onggole Peranakans resulting in a rumen pH of 7.6–8.4, but these results are higher than those reported by Jamarun et al. (2019) which is 6.78–6.80. The pH score in this study is still within normal level to support the growth of rumen microbes. Rumen pH is one of the major factors affecting rumen microbial populations and produces fermented products in the form of VFA and NH<sub>3</sub> (Huyen et al., 2016).

The addition of 0–0.3% FOPFE in the ration did not affect the total VFA of rumen fluid, the same result was reported by Sunarjoko (2015). This shows that rumen microbial activity is not disturbed by the addition of FOPFE. FOPFE in this study had 0.33% tannin compounds (analysis of the Balitnak Laboratory, 2018). The score of tannin in the rumen ecosystem will affect the activity of rumen mi-

croorganisms because it can bind proteins so that protein cannot be utilized by rumen microbes, but tannins in certain amounts are beneficial to rumen microbes. The total VFA in this study was 37.38–53.95 mM, the similar results were reported by [Purbowati et al. \(2014\)](#) i.e., 42.18–43.72 mM; [Yang et al. \(2016\)](#) i.e., 34.1–38.6 mM; and [Putra et al. \(2017\)](#) i.e., 52.49–54.97 mM; but lower than those reported by [Samadi et al. \(2020\)](#) which is 83–108 mM. In this study, the same type of carbohydrate and physical form of the ration caused the consumption of the same ration so that the characteristic rumen conditions were the same (pH, VFA and  $\text{NH}_3$ ).

The level of rumen  $\text{NH}_3$  in this study was 3.77–5.60 mM, a sufficient amount to support microbial's growth.  $\text{NH}_3$  levels to support rumen microbial protein synthesis is ranging from 3.87–5.23 mM ([Suharlina et al., 2016](#)); and/or 4.63–6.37 mM ([Tarigan et al., 2018](#)). High and low concentrations of  $\text{NH}_3$  in the rumen are influenced by several factors like the level of protein in ration, ration degradability, and how long the feed is in the rumen and rumen pH.

The addition of 0–0.3% FOPFE in the ration did not affect the level of ammonia ( $\text{NH}_3$ ) rumen fluid but tended to decrease ammonia levels in P1 (4.13 mM) and P2 (3.77 mM) compared to controls (5.60 mM). The decrease in  $\text{NH}_3$  levels shows that tannin contained in FOPFE can bind the proteins so that protein of feed escapes from the rumen degradation process and increases the protein bypass which can be absorbed in the small intestine.

The absence of influence ( $P > 0.05$ ) of the addition of FOPFE in the ration to the levels of erythrocytes, hematocrit, hemoglobin, ureum and glucose shows that the tannin content in FOPFE is still low (0.33%), so that FOPFE is safe for livestock consumption, does not interfere with the normality of red blood cells and can maintain blood metabolites ([Table 3](#)). The addition of tannin extract did not affect blood metabolites ([Jolazadeh et al., 2015](#)); substitution of soybean meal with Moringa leaves containing tannins do not affect blood metabolites ([Rohmah et al., 2020](#)). Tannin can bind to proteins and interfere with Ferrum (Fe) absorption ([Fajrina et al., 2016](#)). The addition of 0–0.3% FOPFE in the ration did not affect the levels of goat erythrocytes. This shows that although the tannin contained in FOPFE can bind the protein because the dose is still low at 0.33% and livestock can still be tolerated so that it does not cause interference with erythrocyte levels. The addition of Moringa leaves in the ration did not affect the total erythrocytes, hemoglobin and hematocrit in pre-weaned goats ([Rohmah et al., 2020](#)).

The average of hematocrit levels (%) in goats given FOPFE at the level of 0–0.3% ranged from 20.03 to 23.63%

([Table 3](#)). The score of hematocrit did not differ between treatments because red blood cell levels were also not different. Hematocrit is a comparison of erythrocytes with blood so that the score is positively correlated with total erythrocytes. The hematocrit score in this study is still in normal condition as reported by [Merdana et al \(2020\)](#) the hematocrit of Bali cattle is  $30.50\% \pm 2.66$  and the hematocrit of goat is 27.5% ([Mandal et al., 2017](#)). This shows that hematocrit levels are still in normal condition and cattle are in good health. Dehydration triggers an increase in hematocrit while nutritional deficiencies will reduce the value of hematocrit ([Frandsen, et al., 2009](#)). Increasing the hematocrit can increase blood viscosity ([Babe et al, 2015](#)). Hemoglobin levels in this study were 7.8–8.7 g/dL and did not differ between treatments. Similar results were reported by [Min et al. \(2015\)](#), the addition of 30% condensed tannin pine bark in the ration did not affect the levels of goat hemoglobin with levels of 9.98–10.5 g/dL and [Rohmah et al. \(2020\)](#) addition of Moringa leaf flour in ration did not affect the pre-weaning hemoglobin level of the sheep with a hemoglobin level of 6.13–7 g/dL. Hemoglobin in all treatments did not differ because the levels of erythrocytes and hematocrit were also the same. There are a positive correlation between erythrocyte levels, hematocrit and hemoglobin levels. One part of erythrocytes is hemoglobin which functions to bind oxygen ([Frandsen et al., 2009](#)). Hemoglobin levels are influenced by internal factors (sex, age, nutritional and physiological status) and external (environmental).

The average urea of blood (mg/dL) of goats given 0–0.3% FOPFE in the ration was 32.20–39.60 mg/dL. This value is still in the normal range, the normal blood urea level of ruminant animal ranges from 26.6 to 56.7 mg/dL ([Hungate, 1966](#)). This case shows the tannin content in FOPFE in the ration did not interfere with the utilization of protein in the rumen. Blood urea is an indicator to determine the utilization of feed protein and ammonia by microorganisms in the rumen. The higher protein ration will increase blood ammonia and blood urea levels ([Patra, 2015](#)). Proteolytic activity of proteins and NPN in the rumen also influences blood urea levels ([Kang et al., 2015](#)). If the level of urea in the blood is high, it shows that the rumen microbes are not maximally utilizing ammonia and vice versa if the blood urea level is low, it means that the use of ammonia in the rumen is high ([Frandsen et al., 2009](#)). The same thing was reported by [Sujarnoko \(2015\)](#), administration of tannin extract from Chesnut did not affect blood urea levels in sheep and [Ghaffari et al. \(2013\)](#) hay alfalfa substitution with Pistachio By Product (PBP) did not affect blood metabolites (cholesterol, triglyceride, blood urea nitrogen, total protein, albumin, and glucose) dairy goats.

The average blood cholesterol in goats given FOPFE



0-0.3% in the ration was 79.67-101.00 mg/dL. The addition of FOPFE (0-0.3%) significantly ( $P<0.05$ ) reduced blood cholesterol levels. The highest cholesterol level was in the P1 treatment (0.1% FOPFE in the ration) which was 101.00 mg/dL, significantly different from the other treatments. The FOPFE increase from 0.1% to 0.2% significantly ( $P<0.05$ ) reduced cholesterol levels. This shows an increase in tannin levels in FOPFE (0.1% to 0.2%) can reduce cholesterol levels. It is suspected that tannin inhibits the action of HMG-CoA reductase and acyl-coenzyme A cholesterol acyltransferase (ACAT) to synthesize and absorb cholesterol, tannin also binds bile acids so that cholesterol levels decrease. Cholesterol reduction through the mechanism of a) binding of bile acids in a smooth manner thereby increasing the secretion of fecal bile acids, b) decreasing cholesterol and fat absorption, c) decreasing serum insulin rate which decreases stimulating cholesterol and lipoprotein synthesis and d) inhibiting cholesterol synthesis by chain fatty acids short (Dhesti et al., 2014).

The average blood glucose of goats that was given FOPFE 0-0.3% in the ration was 50.33-57.3 mg/dL and did not differ between treatments. This condition was caused by the nutritional content of the ration between treatments is the same, so that the supply of carbohydrates for glucose formation is relatively the same so that the addition of FOPFE in the ration does not affect glucose levels. Similar results were reported by Rostini and Zakir (2017) differences in the composition of forage and concentrate did not influence the goat glucose levels, namely 60.15-65.65 mg/dL, and Mayulu et al. (2012) giving amofer from palm plantation waste did not affect glucose levels in sheep, namely 73.70-81.18 mg/dL.

## CONCLUSION

Fermented Oil Palm Fronds Extract (FOPFE) can be fed to goats, because it does not negatively affect rumen fermentation and blood metabolites, but can reduce cholesterol levels in goats when fed 0.2% in feed.

## CONFLICT OF INTEREST

We certify that there is no conflict of interest with any financial, personal or other relationships with other people or organizations related to the material discussed in the manuscript.

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All authors contributed to conducting research and writing this manuscript.

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