

1 Running head : supplementation complete feed based on oil palm frond for  
2 Kacang Goats  
3

4 **DIETARY SULFUR AND PHOSPHORUS SUPPLEMENTATION ON**  
5 **KACANG GOATS FED DIET CONTAINING FERMENTED OIL**  
6 **PALM FRONDS**

7

8 **T. Astuti<sup>1\*</sup>, A. Jayanegara<sup>2</sup> U. Santoso<sup>3</sup> and Syahro A. Akbar<sup>1</sup>,**

9 *<sup>1</sup> Department of Animal Science, Faculty of Agriculture Mahaputra*  
10 *Muhammad Yamin University, Jl. Jend. Sudirman No 6 Solok City, West*  
11 *Sumatera. Indonesia*

12 *<sup>2</sup> Department of Nutrition and Feed Technology, Faculty of Animal*  
13 *Science, IPB University, Jl. Agatis Kampus IPB Dramaga Bogor 16680,*  
14 *Indonesia*

15 *<sup>3</sup>Department of Animal Science, Faculty of Agriculture, IPB University,*  
16 *Jalan Raya W.R. Supratman, Kandang Limun, 38371A, Bengkulu, Indonesia*

17 *\*Corresponding author: [adektuti@mail.com](mailto:adektuti@mail.com) . HP +62 81366334915*

18

19 **ABSTRACT**

20 The research purpose to evaluate the effect of sulfur and phosphorus  
21 supplementation in the complete feed-based fermented oil palm fronds (OPF)  
22 on the nutrient digestibility, consumption of feed, average daily gain, and feed  
23 efficiency of Kacang goats. Using the completely randomized design by 4  
24 treatments with 4 replicates for the analysis in vitro method of diet and a block  
25 randomized design for the performance of goats in this research. The diet  
26 treatment consisted of 40% fermented OPF + 60% concentrates. The dietary

1 treatments consisted of R1 = control ration (40% fermented OPF + 60%  
2 concentrate) without sulfur and phosphorus supplementation. R2 = R1 + 0.4%  
3 sulfur, R3 = R1 + 0.27% phosphorus, and R4 = R1 + 0.4% sulfur + 0.27%  
4 phosphorus. The results of this experiment showed the significant effect of  
5 the sulfur and phosphorus supplementation in the complete feed on dry matter  
6 and organic matter digestibility ( $p < 0.05$ ), but no effect on; crude; protein,  
7 fiber, and the performance of goats. It could be concluded that the sulfure and  
8 phosphorus supplementation had no effects on feed intake, daily gain, and  
9 feed efficiency of Kacang goats.

10 **Keywords: Sulfur, phosphorus, complete feed, oil palm frond,** fermented

11

## 12 INTRODUCTION

13 Indonesia is one of the largest producer plantation of palm oil in the  
14 world's with a total area of approximately 11,300,400 ha (Statistic Indonesia,  
15 2019). Plantation technology has reached to zero waste. Almost every part of  
16 the tree has been studied for its application in various fields including energy,  
17 food, materials, manufacturing and so forth. In the field of veterinary, the oil  
18 palm leaves or pruned oil palm fronds (OPF) have been found suitable for  
19 feeding the goats. The availability of OPF has the potential to be used as  
20 ruminant feed as a substitute for forage. Warly et al, (2017). The dry matter  
21 and crude protein digestibility of 60% OPF in Simmental cattle were 59.40 %  
22 and 59.40%. Unfortunately, the disadvantage of OPF have their high lignin  
23 content and the low of digestibility nutrients. Astuti's researched (2017) the  
24 lignin content of OPF mixed with concentrate was 11,64%. The dry matter

1 and organic matter digestibility of OPF was 35,47% and 53,68% (M. Tahsin,  
2 et al, 2018).

3 The technology of fermentation could improve the nutritional contents of  
4 feeds, and increase their biological values when being utilized by animals  
5 (Steinkraus, 2002). Some fermentation studies of animal feeds used  
6 commercial microorganisms of fungi, bacteria, and others, but in this research,  
7 the OPF were fermented by the source of the local microorganism of the  
8 rumen liquor. Astuti et al. (2016) use of local waste as a source of  
9 microorganisms was very profitable because of the cheaper cost and the  
10 process was easier. Furthermore, Astuti et al. (2019) reported that  
11 fermentation process OPF by local microorganisms of the rumen liquor, and  
12 *Lactobacillus* sp. with the addition of water-soluble carbohydrates could  
13 decrease the content of ADF, NDF, cellulose, and lignin of OPF. Akin et al.  
14 (1983) described that the microbes could be stimulated by adding sulfur, and  
15 improved animal weight gain. Rumen microbes could use sulfur to synthesize  
16 sulfur-containing amino acids (Karto, 1999). Sulfur (S) is part of cysteine  
17 and methionine (Richter, 2011) and a precursor for the other S-  
18 containing amino acid (NRC, 2000). Sulfur deficiency decreased the  
19 growth of rumen microbes and reduced their contribution to forage digestion  
20 (Bal and Ozturk, 2006). A lower phosphorus content in the rumen causes  
21 reduce rumen microbial growth and thereby reduces cellulose  
22 degradation (Witt and Owens, 1981). This researc purpose to analyze the  
23 effect of sulfur and phosphorus supplementation in complete feed-based  
24 fermented OPF on the production performance and nutrient digestibility of  
25 Kacang goatsThe supplementation of sulfur and phosphorus in the diet

1 treatment be thought to affect the digestibility of nutrients and the production  
2 performance of goats

3

4

## MATERIALS AND METHODS

### 5 **Feed preparation**

6 The rumen liquors were taken from the abattoir and put into a tube,  
7 added with sugar and coconut water to feed microorganisms, then incubated  
8 for 10 days with anaerobic (Astuti et al., 2016). This mixture was called local  
9 microorganisms. Crushed OPF was mixed with these local microorganisms  
10 and then incubated for 7 days to generate the fermented OPF

11 The complete feed was composed of fermented OPF (as a forage) and  
12 concentrate mixture. The ration formulation consisting of forage and  
13 concentrates base on the nutritional requirements of Kacang goats. The  
14 mixture or complete feed was made into biscuit by pressing and drying  
15 procedures, and each biscuit had a dimension of  $5 \times 7 \times 2 \text{ cm}^3$ . The complete  
16 feed biscuits were light brown in color cause of a non-enzymatic browning  
17 reaction. The purpose of making biscuits is to reduce dust, increase  
18 palatability, reduce feed residue, reduce feed volume, and facilitate handling,  
19 storage, and transportation (Saenab et al., 2010).

### 20 **Experimental animals**

21 A total of 16 Kacang goats (body weight ranged from 9.5 to 24.7 kg)  
22 were employed in the present experiment. Guideline for ethics study of  
23 experimental animals based on the law of the Republic of Indonesia number  
24 18 of 2009 about Animal livestock and animal husbandry. All the goats were  
25 placed in individual cages and received experimental diets at a level start of

1 3% body weight on a dry matter basis. Kearl (1982) stated that the nutrient  
2 requirement of goat (BW10-20 kg, ADG 75 g) is about 3.1-3.5% of body  
3 weight). The goats were obtained from the farmers who have kept the previous  
4 extensification. Thus, it need the preliminary and introduction fase before  
5 starting experiment.

6

### 7 **Experimental design and data analysis**

8 The research design has done using a completely randomized with four  
9 treatments and four replicates. The dietary treatments consisted of R1 =  
10 control ration (40% fermented OPF + 60% concentrate) without sulfur and  
11 phosphorus supplementation. R2 = R1 + 0.4% sulfur, R3 = R1 + 0.27%  
12 phosphorus, and R4 = R1 + 0.4% sulfur + 0.27% phosphorus. A block  
13 randomized design was used to evaluates the performances of goats. The  
14 formulation of ration treatment were presented in Table 1.

15 The observed variables in the present study were nutrient digestibility  
16 such as dry matter (DM), organic matter (OM), crude protein (CP) and crude  
17 fiber (CF) digestibilities. The performances of goats such as feed intake, daily  
18 gain, feed efficiency wee also measured. Moisture, CP, CF, and ash were  
19 analyzed using the AOAC method (AOAC, 2011), while the nutrient  
20 digestibility was measured using an *in vitro* rumen fermentation technique  
21 (Tilley and Terry, 1963).

22 The analysis of variance used to analyze all data and continued using  
23 Duncan's multiple range tests when a certain variable showed significance at  
24  $P < 0.05$ .

25

## RESULTS

1

### 2 **Nutrient Digestibility**

2

3           The nutrient digestibility of the experimental diets is presented in Table  
4 2. The experimental results showed that dry matter and organic matter  
5 digestibilities were significantly affected ( $P<0.05$ ), whereas crude fibre and  
6 crude protein digestibilities did not significantly affected ( $P>0.05$ ). It was  
7 showed that R1 had more lower DM digestibility than R2,

8

### 9 **Performance of Kacang Goats**

9

10           Table 3 shows the effect of experimental diets on feed intake,  
11 feed efficiency, and daily gain of Kacang goats. Experimental results shows  
12 that feed intake, feed efficiency and daily gain were not significantly affected  
13 by the treatments ( $P>0.05$ ).

14

## 15 **DISCUSSION**

15

### 16 **Nutrient digestibility**

16

17           It is quite interesting that the 0.4% sulfur in the feed formulation (R2)  
18 had higher the digestibility of both dry matter and organic matter as compared  
19 with the phosphorus (R3) and the sulfur-phosphorus mixture (R4). The  
20 supplementation of sulfur and phosphorus to the complete feed based on OPF  
21 may be unable to optimize the functioning of rumen microbes to produce the  
22 fiber and protein digestive enzymes. Tahsin et al. (2018) reported that the  
23 digestibility of DM and OM of fermented OPF were 58.56 and 73.88%,  
24 respectively.

1           The sulfur supplementation failed to improve the crude protein and  
2 crude fiber digestibilities. it is possible that the dose of sulfur was unadequate  
3 to upgrade the functioning of rumen microbes. This result was different from  
4 Zain et al. ( 2010) who reported that sulfur supplementation to the rice straw  
5 ammoniation could improve the DM, OM, CP, and CF digestibilities.

6

### 7 **Performance of Kacang goats**

8           The supplementation of sulfur and phosphor to the complete feed  
9 based on fermented OPF did not affect the palatability resulting in similar feed  
10 intake. **The feed intaked on this research about 462-480 gram/ head/day.** The  
11 result of this research was similar to the research of Nurhaita et al. (2014) who  
12 declare that the average of feed intake ranged from 307,25% - 375,79%  
13 g/head/day. The feed inatke result of this research was lower than Musnandar  
14 et al (2011) who reported that the average of feed intake was 895.87 g/day.

15           The goats weight daily gain, feed intake, and feed efficiency were not  
16 affected by sulfur and phosphor supplementation. **The daily gain of goats**  
17 **research about 16.6 - 52.2 gram/day, and the highest on R1 treatment (control**  
18 **ration without supplementation S and P).** This was because the Kacang goats  
19 have typically small size of weight and the low of daily gain (Setiadi, 2003),  
20 and suspect doses of supplementation S and P not affect the activity rumen  
21 microbe of goats in this research.

22           **The result of this researched was similar with the saragih resulted**  
23 **(2014) that used OPF silage as feeding of kacang goats, and getting about 9.14**  
24 **– 50.57 gram/head/day daily gain.**

25

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25

## CONCLUSION

Supplementation of sulfur and/or phosphorus improved DM and OM digestibility but had no effects on CP and CF digestibility. The supplementation had no effects on feed intake, daily gain and feed efficiency of Kacang goats.

## ACKNOWLEDGMENTS

Thank you so much to the Directorate Research and Community Service, the Indonesian Ministry of Education and Culture has funded this research

## CONFLICT OF INTEREST

The author state that there is no conflict of interest for this article

## REFERENCES

- Akin, D. E, Gordon G.L, and Hogan J. P. (1983). Rumen bacterial and fungal degradation of *Digitaria pentzii* grown with or without sulfur. *Applied and Environmental Microbiology*, Sep;46(3):738-48
- AOAC. (2011). *Official methods of analysis of the Association of Official Analytical Chemists International*. In *Recovery studies*, 17th edn. Byrd Richmond, VA.
- Astuti, T., Amir Y, Santoso U, and Irdawati (2016). Nutritional Improvement of Palm Oil Fronds for Ruminant Feedstuffs Using a Local Biotechnological Approach. *15(27)*, 450–454.
- Astuti T, Santoso U, and Amir, Y. (2017). Nutritional value of fermented palm oil fronds as a basis for complete feed for ruminants. *Pakistan Journal of*



- 1           Nutrition.
- 2   Astuti, T, M. Nasir Rofiq, Nurhaita, U. Santoso. 2019. Analysis of Fibre  
3           Fraction of Palm Oil Frond Fermented with Different Microbes and  
4           Soluble Carbohydrates Addition as Ruminant Feeding. IOP Conf. Series:  
5           Earth and Environmental Science 347 (2019) 012059
- 6   Bal, M.A. and D. Ozturk, 2006. Effect of sulfur containing supplements on  
7           ruminal fermentation and microbial protein synthesis. Res. J.Anim. Vet.  
8           Sci., 1: 33-36
- 9   M Tafsir , Y Khairani , N D Hanafi and Yunilas. (2018). In vitro digestibility  
10          of oil palm frond treated by local microorganism (MOL). IOP Conf.  
11          Series: Earth and Environmental Science 122 (2018) 012134
- 12   Musnandar E, A.Hamidah and R.A. Muthalib. 2011. The Effect Of Fermented  
13          Oil Palm Fronds In Diet On Body Weight Gain And Meat Quality Of  
14          Goat. J.Indonesian Trop.Anim.Agric. 36(2) June 2011. p 120-125
- 15   NRC., 2000. Nutrient Requirements of Beef Cattle. 7th Rev. Edn., National  
16          Academic Press, Washington, DC., USA., Pages: 242.
- 17   Nurhaita, Ruswendi, R. Wismalinda and Robiyanto. 2014. Utilization of palm  
18          oil frond as forage source in cattle ration. Jurnal Pastura, 4 (1): 38 – 41
- 19   Karto A.A. 1999. Peran dan kebutuhan sulfur pada ternak ruminansia.  
20          Wartazoa. Vol.8 No.2 page-38-44
- 21   Saenab, A., E.B. Laconi, Y. Retnani and M.S. Mas'ud, 2010. Quality  
22          evaluation of shrimp by- product complete ration pellets. JITV., 15:  
23          31-39.
- 24   Saragih H. 2014. Penggunaan limbah perkebunan untuk pengembangan ternak  
25          kambing. Wahana inovasi volume 3 No.1 JAN-JUNI 2014 page 157-  
26          162  
27

- 1 Setiadi,B. 2003.Alternatif konsep pembibitan dan Pengembangan Usaha  
2 Ternak Kambing. Makalah Sarasehan “Potensi Ternak Kambing dan  
3 PropekAgribisnis Peternakan”, 9 September 2003 di Bengkulu
- 4 Statistic Indonesia. 2019. <https://www.bps.go.id/>
- 5 Steel, R, Torrei J, and Dickey D. (1997). Principles and Procedures of  
6 Statistics A Biometrical Approach. In A Biometrical Approach. > ???
- 7 Steinkraus, K. H. (2002). Fermentations in world food processing.  
8 Comprehensive Reviews in Food Science and Food Safety.  
9 <https://doi.org/10.1111/j.1541-4337.2002.tb00004.x>
- 10 Tilley, J. M. A., and Terry, R. A. (1963). A two-stage technique for the in  
11 vitro digestion of forage crops. *Grass and Forage Science*.
- 12 Warly L, Suyitman, Evitayani and Armina Fariani. 2017. Nutrient  
13 Digestibility and Apparent Bioavailability of Minerals inBeef Cattle Fed  
14 with Different Levels of Concentrate and Oil-palmFronDs. Pakistan  
15 Journal of Nutrition. 16 (3): 131-135, 2017
- 16 Witt, K.E. and F.N. Owens, 1981. Ruminant availability of phosphorus and its  
17 effect on digestion. Animal Science Research Report, pp: 151-157.  
18 [http://beefextension.com/research\\_reports/research\\_56\\_94/rr81/rr81\\_44.p](http://beefextension.com/research_reports/research_56_94/rr81/rr81_44.pdf)  
19 [df.](http://beefextension.com/research_reports/research_56_94/rr81/rr81_44.pdf)
- 20 Zain, M., Jamarun, N, and Nurhaita. (2010). Effect of sulfur supplementation  
21 on in vitro fermentability and degradability of ammoniated rice straw.  
22 Pakistan Journal of Nutrition.
- 23  
24  
25 .

1

2

3

4

5

6

7

8

# AUTHOR QUERY FORM

**Journal:** AAVS

**Article Name:** Dietary Sulfur and Phosphorus Supplementation on Kacang Goats Fed Diet Containing Fermented Oil Palm Fronds

**Corresponding Author:** T. Astuti

## Author Queries:

1. During the process of final proofreading and typesetting of your manuscript, the following queries have arisen. The queries are related to RED text in the galley proof. Please check your typeset proof carefully against the queries listed below and make the necessary changes either on this query form or directly on the PDF galley proof. **Watch short demo** (<http://www.youtube.com/watch?v=VsvY660PIok>) or **follow the page given beneath** for making changes directly in the pdf.

2. **No further changes will be allowed once article will be fully published.**

Query Ref	Page number	Details required	Author's response
AQ1		Please <b>carefully check</b> : 1) Names of all authors (First Name and Surname) 2) They are given in the correct order 3) Their affiliation are labelled and are given in the correct order Please note that once the article has been submitted the list of authorship is not liable to be changed. No additions, deletions or change in order will be accepted/allowed.	
AQ2		Please check for the scientific names and confirm that they all are given in correct order and italic font style.	
AQ3		Please go through the reference list and delete the references that are not cited in the text.	
AQ4	All	The references in red are not given in the reference section of the article. Please provide these.	
AQ5	4	Please provide contents under "Authors Contribution" (how authors contributed in creating the article)	
AQ6	3	Please provide Novelty statement.	
AQ7	4	Please check and complete the references section.	

Any query or additional file related to the article may be sent to email [managingeditor@nexusacademicpublishers.com](mailto:managingeditor@nexusacademicpublishers.com)

## Making Corrections in Galley Proof (PDF) File

Please follow these instructions to mark changes or to add notes in the galley proof. You can use Adobe Acrobat professional version 7.0 (or onwards) or Adobe Reader 8 (or onwards)). The latest version of Adobe Reader is available to download for free at [get.adobe.com/reader](http://get.adobe.com/reader).

For additional help please use the [Help](#) function or, if you have Adobe Acrobat Professional 7.0 (or onwards), go to [http://www.adobe.com/education/pdf/acrobat\\_curriculum7/acrobat7\\_lesson04.pdf](http://www.adobe.com/education/pdf/acrobat_curriculum7/acrobat7_lesson04.pdf)

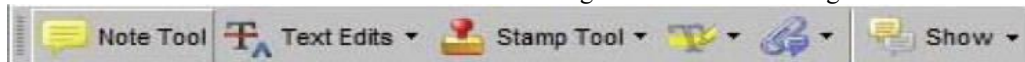
### Displaying the toolbars

To display the toolbar please follow this link:

**Adobe Reader 8:** Select Tools → Comments & Markup → Show Comments and Markup Toolbar. You must see the following bar:



**Acrobat Professional 7:** Select Tools → Commenting → Show Commenting Toolbar.

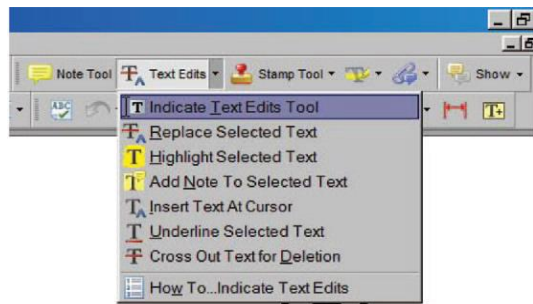


**Adobe Reader 10:** To edit the galley proofs, use the Comment Toolbar (Sticky Note and Highlight Text).



### Using Text Edits

This is the quickest, simplest and easiest method both to make corrections, and for your corrections to be transferred and checked.



1. Click **Text Edits**
2. Select the text to be annotated or place your cursor at the insertion point.
3. Click the **Text Edits** drop down arrow and select the required action.

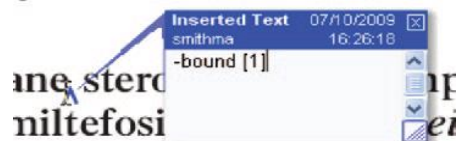
You can also right click on selected text for a range of commenting options.

### Saving the comments: Don't forget to save the comments

To save your comments, save the file (File → save) before closing.

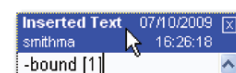
### Pop up Notes

With **Text Edits** and other markup, it is possible to add notes. In some cases (e.g. inserting or replacing text), a pop-up note is displayed automatically.



**Display:** To display the pop-up note for other markup, right click on the annotation on the document and selecting **Open Pop-Up Note**.

**Move:** To move a note, click and drag on the title area.



**Resize:** To resize the note, click and drag on the bottom right corner.



**Close:** To close the note, click on the cross in the top right hand corner.



**Delete:** To delete a note, right click on it and select **Delete**. The edit and associated note will be removed.