Nutrient quality of oil palm frond fermented by local microorganism (MOL) with different dosage and incubation time

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Abstract. This research purpose to know the effect of fermented feed processing technology with different dosage and incubation time towards nutrient quality of oil palm frond. The design used in the research was the factorial completely randomized design with three replicates. The treatment consist of four dosage of MOL, namely 0; 0.2; 0.4; and 0.6% for the first factor, and the second factor is incubation time of 7; 14; 21 days. The research results showed that the utilization of MOL with can significantly (P<0.05) improve nutrient quality base on proximate analysis and also on neutral detergent fibre (NDF) and acid detergent fibre (ADF) content. It is concluded that utilization of MOL can improve nutrient quality based on proximate analysis and also on neutral detergent fibre (NDF) and acid detergent fibre (ADF) content. Utilization MOL 0.6% with incubation time 21 days show the best combination treatment to improve OPF for ruminant feed.

1. Introduction
Indonesia had the highest land use for oil palm plantation in the world, and also produce by-products that can be used as feed for ruminant. By product which is produced from the oil palm plantation which have high availability is oil palm fronds (OPF) [1] and OPF have been used as a substitute for grasses as main source for feed in ruminant [2]. Palm tree can produce 22 Oil palm frond (OPF) /tree/year, with average weight of OPF 2.2 kg, so that each hectare of oil palm plantation can produce OPF reach 9 ton/ha/year (as fed basis) or equal to 1.64 ton /ha / year of dry matter [3]. The content of nutrients of OPF had low Crude Protein content (5.3%), and high in Crude Fibre (31.09%) and Lignin (16.9%) [4]. This condition became the limiting factor the utilization of OPF as animal feed [5]. Provision OPF in high amount on feed will affect the digestibility of nutrient and also contribute on animal performances, so the technology needed to fix it.

The technologies that can be applied to improve the low quality of feed including fermentation technology by microorganisms to degrade crude fibre/lignin levels to increase the digestibility of feed [6]. Our previous study indicated that Fermented oil palm frond using combination Aspergillus niger and Saccharomyces cerevisiae buffalo rumen bacterial isolates increase in vitro digestibility [7]. Optimization of fermentation process were needed to improve the quality of fermented oil palm fronds. Quality of fermented product depend on several, factor, including dosage and length of incubation
time. According to this situation, this study is to find out the effect of different dosage and incubation time on nutrient quality of oil palm frond fermented by local microorganism (MOL).

2. Materials and methods

The research was done in Feed and Nutrition Science laboratory, Animal, Faculty of Agriculture, Universitas Sumatera Utara, Medan, while nutrient quality were analysis in Goat Research Centre Laboratory, Livestocks Research and Development Center, in Sei Putih, North Sumatra. The research used experimental design using completely randomize factorial design [8] with two factors, which were factor A local microorganism (MOL) dosage and factor B duration of fermentation. The data were analysed using analysis of variance procedure (ANOVA) and for further analysis using Duncan multiple range test (DMRT).

The treatment in this experiment consist of two factor, namely: factor A dosage of isolate MOL (0%, 0.2%, 0.4%, and 0.6%) and factor B length of incubation time (7.14 and 21 days). Each treatment consist of three replications. The experimental design used factorial design with mathematic models:

$$Y_{ijk} = \mu + \alpha_i + \beta_j + (\alpha\beta)_{ij} + \varepsilon_{ijk}$$

Note:

- $Y_{ijk}$ = data
- $\mu$ = grand means
- $\alpha_i$ = effect dosage
- $\beta_j$ = effect incubation time
- $(\alpha\beta)_{ij}$ = interactions between dosage and incubation time
- $\varepsilon_{ijk}$ = error

Oil palm fronds (OPF) were obtained from Goat Research Centre Sei Putih, and blend using chopper machine. The local microbes (MOL) were used composed of Aspergillus niger ($10^6$ cfu-ml), Saccharomyces cerevisiae ($10^6$ cfu-ml), and three isolates of buffalo rumen bacteria ($10^{10}$ cfu-ml) were obtained from previous study. OPF were sterilized using autoclave at 121°C for 15 minutes before were applicated by MOL. The incubation were done using sterile plastic tray at room temperature (28 ± 2°C) on aerob conditions, and the water content of OPF were fixed at 60%.

The Data proximate analysis were collected composed of Dry Matter, Crude Protein, Crude Fat, Crude Fibre, Ash, and Nitrogen Free Extract (NFE) contents. The method for proximate analysis and calculations according to procedure released by AOAC [9]. Furthermore, the analysis for fibre fractions composed of Neutral Detergent Fibre (NDF) and Acid Detergent Fibre (ADF) [10].

3. Results and discussion

| Table 1. Nutrient composition of initial oil palm frond |
|--------------------------------------------------------|
| **Composition** | **Amount** |
| Ash (% DM) | 3.78 |
| Crude Protein (% DM) | 1.06 |
| Crude Fibre (% DM) | 56.1 |
| Crude Fat (% DM) | 0.26 |
| Neutral Detergent Fibre (% DM) | 64.05 |
| Acid Detergent Fibre (% DM) | 79.27 |
| Gross Energy (kcal/kg) | 4,089.7 |
Table 2. The effect of dosage and incubation time on nutrient composition of oil palm frond fermented by MOL

| Dosage (%) | Incubation time (days) | Average |
|------------|------------------------|---------|
|            | 7         | 14      | 21      |          |
| Ash (%)    |           |         |         |          |
| 0.0        | 3.9967    | 3.7800  | 4.1767  | 3.9844 b |
| 0.2        | 4.0000    | 4.2633  | 4.4567  | 4.2400 a |
| 0.4        | 4.1733    | 4.3233  | 4.2067  | 4.2344 a |
| 0.6        | 3.8900    | 3.9933  | 4.3667  | 4.0833ab |
| average    | 4.0150b   | 4.0900b | 4.3017a |          |
| Crude Protein (%) |           |         |         |          |
| 0          | 2.0800    | 1.3700  | 1.6233  | 1.6911c  |
| 0.2        | 2.8100    | 3.4167  | 2.0800  | 2.7689ab |
| 0.4        | 2.0600    | 3.0200  | 1.8300  | 2.3033b  |
| 0.6        | 2.3100    | 2.7900  | 4.7500  | 3.2833a  |
| average    | 2.3150a   | 2.6492a | 2.5708a |          |
| Crude Fibre (%) |           |         |         |          |
| 0          | 55.7600   | 53.1233 | 52.0533 | 53.6456c |
| 0.2        | 55.9267   | 55.3033 | 56.2300 | 55.8200a |
| 0.4        | 53.1200   | 56.3533 | 55.3067 | 54.9267b |
| 0.6        | 53.5833   | 53.6167 | 53.6933 | 53.6311c |
| average    | 54.5975a  | 54.5992a| 54.3208a|          |
| Crude Fat (%) |           |         |         |          |
| 0          | 0.2367    | 0.5567  | 0.6400  | 0.4778b  |
| 0.2        | 0.4133    | 0.6233  | 0.6600  | 0.5656ab |
| 0.4        | 0.5900    | 0.4333  | 0.4533  | 0.4922b  |
| 0.6        | 0.7733    | 0.4900  | 0.7233  | 0.6622a  |
| average    | 0.5033a   | 0.5258a | 0.6192a |          |
| Nitrogen Free Extract (NFE) (%) |           |         |         |          |
| 0          | 37.9267   | 41.1700 | 41.5067 | 40.2011a |
| 0.2        | 36.8500   | 36.3933 | 36.5733 | 36.6056c |
| 0.4        | 40.0567   | 35.8700 | 38.2033 | 38.0433b |
| 0.6        | 39.4433   | 39.1100 | 36.4667 | 38.3400b |
| average    | 38.5692a  | 38.1358a| 38.1875a|          |
| Gross Energy (kcal/kg) |           |         |         |          |
| 0          | 3913.1    | 3949.6  | 4215.0  | 4025.9a  |
| 0.2        | 3965.4    | 3984.8  | 4002.4  | 3984.2ab |
| 0.4        | 3950.6    | 4090.6  | 3735.1  | 3925.4b  |
| 0.6        | 3966.2    | 4091.5  | 3754.5  | 3937.4ab |
| average    | 3948.8b   | 4029.1a | 3926.8b |          |

Note: superscripts with different letter in row or column showed significant differences (P< 0.05)

The OPF nutrition composition used in this study is presented in Table 1. The content of the OPF protein from the analysis shows that the content is very low (1.06%) and has a very high crude fibre which reaches 56.1%. The OPF content in this study is lower than the result of analysis which reached 7% [5]. Factors that caused the difference was the different materials used in this study using palm oil bark without using leaves. These conditions make the need to improve the quality of OPF nutrition in order to meet the needs of ruminant livestock, and can be done using fermentation technology.
The observed data on the effect of MOL on the nutrient content of OPF are presented in Table 2. Statistical analysis showed that dosage treatment and incubation time significantly affect (P <0.05) on ash content of fermented OPF. The use of doses 0.2-0.6% did not show significant difference (P> 0.05), but the control treatment showed the lowest result compared to the use of MOL. The 21-day fermentation period also showed higher ash content compared to the fermentation time of 7 and 14 days. The content of OPF proteins is also influenced by the dose treatment, but fermentation duration 7 to 21 days did not show significant difference (P <0.05). The control treatment showed the lowest protein content compared with the use of MOL, and the use of 0.6% dose showed the highest protein content of fermented OPF.

The crude fat content of fermented OPF was not influenced by the length of incubation (P> 0.05), but the dose of MOL had significant influences on fat content (P <0.05). The use of MOL will increase the fat content of fermented OPF, and the use of MOL 0.6% indicates the highest crude fat value. A review of the gross energy content showed that the use of MOL 0.2-0.6% did not show any significant difference (P> 0.05), and the use of MOL tended to have a lower gross energy content than the control. Treatment of 7-21 days incubation did not show significant difference (P <0.05), but the MOL dose had significant effect on crude fibre content of OPF. The lowest crude fibre content was found in the control treatment and was not significantly different with the treatment of MOL 0.6%, but significantly lower than the use of MOL 0.2 and 0.4%. The NFE content of OPF on the control treatment statistically shows a higher value compared to the use of MOL.

Analysis of the fibre fraction component of the fermented OPF is presented in Table 3. The incubation period and the MOL dose significantly (P <0.05) affected the NDF content of OPF. The incubation period of 21 days showed significantly higher values compared to incubation 7 and 14 days. The use of MOL 0.6% showed the lowest value compared with other treatments. A review of the ADF content of fermented OPF showed that increased incubation time from 7-21 days significantly decrease the ADF content of fermented OPF. Furthermore, the dose treatment was also statistically had significant effect (P <0.05) on the ADF content. The use of doses 0.2 and 0.4% showed that the ADF content was lower than the control treatment or the dose 0.6%, whereas the use of MOL 0.6% was not significantly different than the control treatment.

Table 3. The effect of dosage and incubation time on fibre fraction of oil palm frond fermented by MOL

| Fibre Fractions (%)       | Dosage (%) | Incubation time (days) | average |
|---------------------------|------------|------------------------|---------|
| Neutral Detergent Fibre (NDF) | 0          | 77.82 79.63 83.95 80.47 | 80.47<sup>ab</sup> |
|                           | 0.2        | 79.34 80.29 84.82 81.48<sup>a</sup> |
|                           | 0.4        | 78.22 78.25 84.99 80.49<sup>ab</sup> |
|                           | 0.6        | 78.17 80.11 82.61 80.30<sup>b</sup> |
|                           | average    | 78.39<sup>a</sup> 79.57<sup>a</sup> 84.09<sup>b</sup> |
| Acid Detergent Fibre (ADF) | 0          | 65.76 67.51 59.09 64.12<sup>a</sup> |
|                           | 0.2        | 62.78 55.96 59.48 59.41<sup>c</sup> |
|                           | 0.4        | 60.43 60.18 60.10 60.23<sup>b</sup> |
|                           | 0.6        | 67.04 61.28 62.61 63.64<sup>a</sup> |
|                           | average    | 64.00<sup>a</sup> 61.23<sup>b</sup> 60.32<sup>c</sup> |

Note: superscripts with different letter in row or column showed significant differences (P< 0.05)

The use of MOL affects the nutrient content of fermented OPF. The content of OPF protein will increase with the use of MOL and at the treatment dose of 0.6% with 21 days of incubation time.
Increasing fermentation time to 21 days will increase the NDF content of OPF, but decrease the ADF content. This result almost similar with another research using OPF fermentation incubated with the rumen contents for 7 days which showed that the treatments significantly affected the contents organic matter, acid detergent fibre, hemicellulose and the digestibility [4]. Utilisation EM4 on OPF also able to improve the physical characteristic and reduce of crude fibre and increase the crude protein with consequence increasing the digestibility in vitro. [11].

In vivo studies utilise OPF on complete feed (wafer feed) reported there were a tendency that the lowest dry matter digestibility on conventional feed compare with complete feed wafer [12]. Biological pre-treatment with fungi on OPF seemed to be promising treatment to improve quality of OPF according to nutrient content as feed for ruminants [13].

4. Conclusions

Utilization of MOL with can improve nutrient quality base on proximate analysis and also on neutral detergent fibre (NDF) and acid detergent fibre (ADF) content. Utilization MOL 0.6% with incubation time 21 days show the best combination treatment to improve OPF for ruminant feed.

References

[1] Abdullah and Sulaiman 2013 The Oil Palm Wastes in Malaysia. Biomass Now – Sustainable Growth and Use Intech Chapter 3 p 75-100 http://dx.doi.org/10.5772/55302
[2] A O Hassan, M Ishida 1992 Status of Utilization of Selected Fibrous Crop Residues and Animal Performance with Emphasis on Processing of Oil Palm Fronds (OPF) For Ruminant Feed in Malaysia. Tropical Agriculture Research Center TARS No.25 (Japan: Ministry of Agriculture, Forestry and Fisheries, Tsukuba)
[3] Diwyanto K D, Manti I, Mathius I W and Soentoro 2003 Pengkajian pengembangan usaha sistem integrasi kelapa sawit- sapi [Assessment of business development integration system of oil palm-cow] Prosiding Lokakarya Nasional [National Proceedings] Bengkulu 9 - 10 September 2003
[4] Astuti T, Santoso U and Amir Y 2017 Nutritional value of fermented palm oil fronds as a basis for complete feed for ruminants Pak. J. Nutr 16 2 p 96-100
[5] Dahlan I 2000 Oil palm frond, a feed for herbivores Asian-Aus J. Anim. Sci 13 Supplement July 2000 C p 300-303
[6] Wina E 2005 Teknologi pemanfaatan mikroorganisme dalam pakan untuk meningkatkan produktivitas ternak ruminansi di Indonesia [Technology utilization of microorganisms in the feed to increase ruminant livestock productivity in Indonesia] Wartazoa 15 4 p 173-186
[7] Tafsin M. et. al. In vitro digestibility of oil palm frond treated by local macroorganism (MOL) IOP Publishing 10.1088 (1755-1315) (2018)
[8] Hanafiah K A 2003 Rancangan Percobaan Teori dan Aplikasi [Theory and Application Experimental Design] (Jakarta: Raja Gravindo Persada)
[9] AOAC Association of Official Analytical Chemist 1991 Official Methods of Analysis (Virginia Arlington, USA)
[10] VanSoest P J, and Wine R H 1967 Use of detergents in the analysis of fibrous feeds IV determination of plant cell wall constituents J. Assoc. Offic. Anal. Chem. 50:50
[11] Rostini T 2017 Inoculanan differences in the quality of physical and nutrition quality palm fermentation fronds as animal feed Journal of Agriculture and Veterinary Science 10 1 p 29-32
[12] Astuti T, Nurhaita G Y, Amir Y 2017 The influence of the form complete feed ruminant With basis of palm oil frond fermentation on the Digestibility of nutrients International Journal Of Advances In Science Engineering And Technology 5 2
[13] Hassim H A, Lourenc M, Goh O Y M, Baars J J P, and Fievez V 2012 Rumen degradation of oil palm fronds is improved through pre-digestion with white rot fungi but not through supplementation with yeast or enzymes Can J. Anim. Sci 92 p 79-87
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