Research Article

The Fiber Profile of Midrib Waste on Salak Sidempuan Fermented with *Phanerochaete chrysosporium*

Profil Fraksi Serat Limbah Pelepah Tanaman Salak yang Difermentasi dengan Kapang Phanerochaete chrysosporium

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Abstract: Feed alternative is become the major concern for livestock industry in order to provide the continuously feeding. Feed technology system based on agriculture wastes were the modified strategy to gain the other sources of feed raw materials. Salak Sidempuan is performed similar with the Palm plantations which is produced the potential midrib waste. Nutritionally, the product will feed the animal to increase the performance. The research aims to evaluate the proximate profile especially the fiber contents of midrib waste of Salak Sidempuan fermented with white root fungi. The fifth experiments were evaluated after the measuring period by using the Phanerochaete chrysosporium and replicated in 4 times. Experiments were P0 (control), P1 (5%inoculant of *P. chrysosporium*), P2 (10%inoculant of *P. chrysosporium*), P3 (15%inoculant of *P. chrysosporium*), and P4 (20%inoculant of *P. chrysosporium*). A completely randomized design was used to determine the statistical effect on dry matter, organic matter, crude fiber and lignin. Results showed that the addition of inoculant about 20% signifantly effected the increasing on dry matter and organic matter while followed the decreasing of fiber contents. In conclusion, fermentation of midrib waste with *Phanerochaete chrysosporium* is potentially degradated the fiber content itselves.

Keywords: Panerochate chrysosporium, Salak midrib waste

Abstrak: Pakan alternatif merupakan fokus utama dalam industri pakan terkait penyediaan sumber pakan yang berkesinambungan. Teknologi pakan berbasis limbah hasil pertanian telah banyak dimodifikasi guna penyediaan sumber bahan baku pakan yang semakin bervariasi. Tanaman Salak Sidempuan memiliki morfologi yang serupa dengan tanaman kelapa sawit serta menghasilkan limbah yang potensial sebagai pakan ternak. Dari aspek nutrisi, limbah tersebut dapat dijadikan sebagai bahan baku pakan untuk produktivitas ternak. Penelitian bertujuan untuk mengevaluasi nilai proksimat khususnya kandungan serat limbah pelepah Salak Sidempuan yang difermentasi dengan kapang pelapuk putih. Lima bentuk perlakuan dievaluasi dengan teknik fermentasi dengan menggunakan *Phanerochaete chrysosporium* dan diulang 4 kali. Perlakuan meliputi P0 (kontrol), P1 (5 % inokulan *P. chrysosporium*), P2 (10 % inokulan *P. chrysosporium*), P3 (15 % inokulan *P. chrysosporium*), and P4 (20 % inokulan *P. chrysosporium*). Penelitian menggunakan Rancangan Acak Lengkap (RAL) untuk melihat pengaruh statistik perlakuan terhadap bahan kering, bahan organik, serat kasar dan kandungan lignin. Hasil penelitian menunjukkan bahwa fermentasi limbah pelepah salak dengan menggunakan inokulan pelapuk putih nyata berpengaruh terhadap parameter dibandingkan dengan kontrol. Dapat disimpulkan bahwa penambahan inokulan sampai 20 % berpengaruh nyata terhadap peningkatan bahan kering dan bahan organik sejalan dengan penurunan kandungan serat.

Kata kunci: Limbah pelepah salak, *Panerochate chrysosporium*

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INTRODUCTION

Salak plants are a type of tropical fruit which is massively spread arround the Indonesia spesificly on tropic area. The plants were mostly found with the high counts in Sleman, Yogyakarta and Padangsidimpuan, North Sumatera (Suryana & Antara, 2020). The type of Salak plants is varied regarding with the taste or the texture itselves. A type of the fruit's plant that is most popular based on the springy texture and sweet taste (with medium acidity) called Salak Sidempuan. The tropical fruits is widely productive in South Tapanuli spesifically on the highland area. A part of the farmers was depend on the plants as the major commodity for daily activities. The yield production of the plants is slightly increased and followed with the waste biomass. The waste consist of fruit's shell, fallen young fruit, midribs, and the unproductive leaf. The increasing of fruit biomass production is directly proportional with the waste biomass production. The waste production of salak's plants was about 31 to 43% per year or equal with 260 to 310 ton per year (Supriyadi *et al*, 2002), while the midrib and the poor leaf biomass were reached to 63.54% from the yield production of waste (Central Bureau of Statistics in South Tapanuli, 2016).

Livestock industry is still having the strong connection with the agriculture sector that is substantially in terms of building food security. In addition, integrated system between agriculture and animal industry can be a smart solution to improve the feeding strategy for animals. The use of feed technology will meet the appropriate way to manage the sustainable processing based on waste by product. For instance, waste biomass from palm plantation is such as midribs and palm kernel meal administring the various product both for commercial and modern livestock. Those type of waste were nutritionally influenced for feeding process (Nurhaita *et al*, 2011). Although the nutrient quality of waste biomass is mostly on poor level, the implementation of feed technology become the exists solution in order to increase the total of biomass nutrient and to empower the animal productivity. It is well known that palms by product was the major component for yielding the fiber to facilitate the ruminanl microbes by adding the technology system (Biyatmoko & Lendhani, 2007). Additionally, for beef industry, providing the fiber source from low nutrient feedstuf will proced to lowering the nutrient standard for the host. At this case, for lignin content, mostly ruminants will show the improvents for fiber digestibility which has contained the lignin standard equal to 11.32% (Liman *et al*. 2010)

Feed fiber components are the complex biomass containing the organic matters which is protected by hemicelluloses and lignins. The profile will effect the degradation way during the ruminal fermentation. Lignin is the polymer structure that is attached in a hole plant and takes the major proportion after the cellulose. This fibre element is also taking the important role the plant to grow. Lignins were called the three dimensions polymer which is containing the units of fenil propana. The polymer structure cannot be convert for the monomer itselves without tested on the basic structure. At the thermal zone, the basic structure of lignin will transform and will gain several new structure; formic acid, methanol, acetat acid, aceton, and vanillin while the other structure will be condensed (Ariani, 2007). Feeding system to increase the quality of lignin is fermentation way. The stage of feeding process will alter the substrates for specific product by adding the biological starters. Fermentation stage will impact the nutrient change within the substrates and it will cause the higher total for nutrient itselves on feed formulation (Chilton et al, 2015). Regarding Shibata & Osman (1988), essential fibre is an organic element that was arranged with hemicelluloses, pectins, and lignins for the primary matrix and also cellulose for the secondary matrix. Fiber elements have to be the energy source for animals that is substantially for ruminants. For example, in case of salak midrib, fiber structure consists of cellulose (31.70%), hemicelluloses (33.90%), lignin (17.40%), and silica (0.6%). Generally, fiber content can be the negative value to lowering the feed quality for waste biomass by product. In details, the complex elements of fiber (hemicellulose and lignin) are the difficult part to digest even for ruminal bachteria and other microbial degradator. However, improving the nutrient proportion based on waste biomass has encouraged the feeding resource beside of forage. Another point is brodening the additional value on plantation area such as Salak Sidimpuan will also enhance the incomes for local farmers themselves.

MATERIALS AND METHODS

Research conducted in July to October 2021 at Laboratory of Feed Technology, University of Graha Nusantara and Van-Soest analysis was held in Laboratory of Nutrition and Feed Technology, IPB University. The experimental research used Salak Midrib waste in Simapilapil village, district of North Padangsidimpuan, the starter of *P. Chrysosporium* was contributed from Culture Center of IPB University, and the growth organic media (GOM). Additionally, research used the chopper with AMPC1200 type, autoclave, dark plastic by 2x1 meters, porcelain cup, material distiller, fermented tray, research marker, fermented sacc, and thermometer.

Experimental design determined in several types namely; preparation of fresh midrib waste of Salak Sidempuan, growth organic media, preparation of *P. Chrysosporium*, fermentation stage, sampling process, proximate analysis and Van-Soest analysis.

Preparation of Salak Midrib Waste (Modified from Rikardo et al, 2018)

The stage is started with chopping the fresh Salak midrib which was categorized as waste biomass. The chopped midribs were selected and separated from other contaminants such as sticks and others. Then, the final product is grinding to meet the fine texture and it is called final substrate of midrib waste (FSMW).

Providing the Growth Organic Media (GOM)

Growth organic media contained the organic materials for the inoculants, substrate of growth organic media contain the organic substrate for the inoculnt itselve, FSMW, isolate of *Phanerochaete chrysosporium*. Before the isolate is through the expansion, GOM and FSMW were sterilized in the first stage. Incubation period was about 7 days to enlarge the total counts of microbe (Yusrizal *et al*. 2013).

Fermentation Stage

A 2000 grams of sterilized FSMW evaluated by using the autoclave with the reproduced inoculants. Then, the formula compacted within the fermented sacc and it was aerobically. The incubation time performed during the 14 days. At the end of the process, final product is reared for sampling and sent out to the laboratory for proximate and Van-Soest measuring.

Research was determined with statistical approach by using the Completely Randomized Design (CRD) with 5 treatments and 4 replicants. The experimental design consist of:

P0: FSMW with no fermentation process
P1: Fermentation of FSMW + 5% inoculants of *P. Chrysosporium*

P2: Fermentation of FSMW + 10% inoculants of *P. Chrysosporium*
P3: Fermentation of FSMW + 15% inoculants of *P. Chrysosporium*
P4: Fermentation of FSMW + 20% inoculants of *P. Chrysosporium*

While the parameters were affected by the treatments, statistical test will allow by Tukey Test (SAS, 2008).

Parameters were evaluated during the research namely dry matter, organic matter, crude fiber and lignin components.

Dry Matter (AOAC, 1984)

Dry matter is tested by measuring the moisture. The formula to determine the dry matter is 100% minus the water content and otherwise. Formula belongs tto the proxymate method.

Dry Matter (%) = 100% - Moisture (%)

Organic Matter (AOAC, 1984)

Organic matter is calculated based on anorganic proportion. The formula to determine is 100% minus of anorganic proportion. Organic matters can be the crosscheck method to evaluate the total of organic matter. This elements will effect the nutrient metabolism in the hole body.

Anorganic Content (%) = $\frac{(H-F)}{G} x\ 100\%$, Organic Matter (%) = 100% - Ash Content (%)

Additional informations: H= Tanur, F= Sample, G= Cups.

Crude Fiber (AOAC, 1984)

Crude fiber is the main factor to evaluate the fermentation stage after using the inoculants. The decreasing or increasing rate of crude fiber will determine the change of feed status especially in terms of digestibility rate.

$$\text{Crude Fiber (\%)} = \frac{Q - R - O}{P} \text{ x } 100\%$$

Addition informations: P= sample weight, O= weight of filtered paper, Q= weight after dried process and R=sample weight from tanur

Measuring the Lignins

Lignin is the organic parties that is lost on ashing stage and the final product of cellulose analysis. Residual within the filtered glass will insert inside the tanur at 550-600 °C about 3 hours. Then, sample is continued for desicator during 30 minutes and counted (grams). Total lignin is being calculated with:

% of Lignin = $\frac{D-E}{A} x\ 100\%$

Additional informations: A= dry weight (g), D =dry matters (g), E = as feed weight (g) [AOAC, 2005]

RESULTS AND DISCUSSION

The Proportion of Dry Matter on Fermented FSMW with *P. Chrysosporium*

The average of dry matter substrates on fermented salak midribs by using the inoculants of *Phanerocheate chrysosporium* as shown in Table 1.

Table 1. Dry matter average of fermented FSMW with *Phanerochaete chrysosporium*

Treatments	Replications		Dry Matters
	1	2	(%)
P0	85.37	85.09	85.23± 0.19
P1	56.13	58.89	57.51± 1.95
P2	73.29	72.84	73.06± 0.31
P3	80.02	79.60	79.81± 0.29
P4	88.93	88.97	88.95± 0.02

Explanations: FSMW (final substrate of midrib wastes) *Significantly influenced (*P*<0.005).

Regarding Table 1, the average of dry matters during the fermented stage showed that inoculated of white root fungi up to 20% of Salak midribs was significantly affected (P<0.005) on the FSMW dry matter. For P4 treatment, the parameter content slightly produced comparing with the other treatments. While control performed the equal proportion with P4 (88.95 %). Additionally, treatment of P2 (73.06 %) and P3 (79.81 %) described the similar counts of dry matter eventhough the P1 (57.51 %) was lower between the other treatment. Based on fermented components of substrate, increasing level of inoculants on fermented FSMW positively showed the dry matters. This will allow to provide the fine solutions for animal feeding sector. Basicly, the availability of dry matter on feed raw materials will influence for the organic matter itselves. Microbes have to play role for the organic sources during the fermentation process. In addition, the digestibility rate of feed nutrients depends on the dry matter quality (Sharma *et al*, 2020).

Concern with the research, P0 and P4 shared the similar proportion to produced the dry matter after the microbial degradated way. The total proportion will perform if the dry matter contents have no degradate in the high rate. The other factor which has connected during the substrate degradation were temperature and the fluctuate humidity. Both higher temperature and relative humidity caused the enzymatic and biological reactions. This process will support with the massive oxidation (Suparjo et al, 2009). Then, the treatment with the addition of inoculants up to 5% did not show the maximum results on dry matter content of FSMW. The resulting dry matter value is 57.51%. The dry matter content is below the minimum standard for ruminant feed sources, which is around 62% to 74% (NRC, 2003). In this treatment, it was seen that the metabolism shown by the inoculants was very optimum in the utilization of dry matter feed. When associated with the P2, P3 and P4 treatments, of course, the dry matter value slightly decreased. The other factors involved including the structure (texture) of FSMW which is thought to be more compact (uniform) and fine impact with the higher decomposition by inoculants. *Phanerochaete chrysosporium* will utilize dry matter for the process of reforming fiber fractions, especially lignin during the fermentation process.

The Proportion of Organic Matter on Fermented FSMW with *P. Chrysosporium*

The average of organic matter substrates on fermented salak midribs by using the inoculants of *Phanerocheate chrysosporium* as shown in Table 2.

Table 2. Organic matter average on fermented FSMW with *Phanerochaete chrysosporium*

Treatments	Replications		Organic Matter
	1	2	(%)
P0	81.17	81.94	81.55± 0.54
P1	80.98	81.78	81.38± 0.57
P2	80.21	80.58	80.39± 0.25
P3	82.89	81.65	82.27± 0.88
P4	82.20	82.23	82.21± 0.01

Explanations: FSMW (final substrate of midrib wastes)

The analysis of variance showed that the average of organic matter due to treatment during fermentation had no significant effect (P>0.005) on the organic component. Approximately, the use of higher inoculants indicates the increase in organic matter. It is suspected that after the fermentation process with lignocellulolytic inoculants, the contribution of secondary metabolite products affects the nutrient composition of the substrate (especially the organic matter content even for the minimum effects). As well as the dry matter content contained in fermented of FSMW. The dry matter value is also used as the correction factor for changes in organic matter. In addition, during the fermentation process the inoculants can remodel the fiber fractions contained in FSMW, causing the availability of organic matter to increase. White root fungi are used to improve the quality of feed ingredients that are difficult to digest. Wina et al, (2005) reported the increase in the digestibility of the organic matter eventhough the lignin and cellulose content in the bark did not decrease.

The Proportion of Crude Fiber on Fermented FSMW with *P. Chrysosporium*

The average of crude fiber substrates on fermented salak midribs by using the inoculants of *Phanerocheate chrysosporium* as shown in Table 3.

Table 3. Crude fiber contents on fermented FSMW with *Phanerochaete chrysosporium*

Treatments	Replications		Crude Fiber
	1	2	(%)
P0	30.42	30.13	30.28± 0.21[a]
P1	19.14	20.46	19.80± 1.93[b]
P2	20.07	19.91	19.99± 0.11[b]
P3	22.98	02.33	12.66± 0.23[bc]
P4	20.64	21.34	20.99± 0.49[b]

Explanations: FSMW (final substrate of midrib wastes) *Significantly influenced (P<0.005).

Based on Table 3, P3 shows the lowest crude fiber content compared to other treatments. It can be seen that the crude fiber content reaches 12.66 % and this value is better for the process of nutrient metabolism, especially for ruminants. Treatment with an increasing of the inoculants up to 20% caused the change for crude fiber. This is presumably due to the activity of inoculants that associate and compete with each other, in which case fellow microbes prey on each other (bacteriophages) so that the secondary metabolites produced cannot donate or degrade the crude fiber (Komang *et al*. 2012). Certaintly, this will also have an impact on the feed nutrition produced. While, P1 (19.80 %) and P2 (19.99 %) produced the same crude fiber content. When compared with the crude fiber value in the control, there was a fairly high decrease. This has a good impact on improving the quality of FSMW as a raw substrate for animal feed, especially ruminants.

The Proportion of Lignin Counts on Fermented FSMW with *P. Chrysosporium*

The average of lignin counts fermented salak midribs by using the inoculants of *Phanerocheate chrysosporium* as shown in Table 4.

Table 4. Lignin counts on fermented FSMW with *Phanerochaete chrysosporium*

Treatments	Replications		Lignin Contents
	1	2	(%)
P0	43,01	43,08	43.04 ± 0.05[a]
P1	40,23	40,26	40.24 ± 0.02[a]
P2	39,72	39,82	39.77 ± 0.07[a]
P3	28,63	28,60	28.62 ± 0.02[b]
P4	29,25	29,30	29.28 ± 0.04[b]

Explanations: FSMW (final substrate of midrib wastes) *Significantly influenced ($P<0.005$).

Based on Table 4, P3 shows the lowest lignin content compared to other treatments. It can be seen that the crude fiber content reaches 28.62 %. This level is more fine for nutritional metabolism processes, especially for ruminants. Treatment with an increase in inoculants up to 20% causes the increasing with the lignin content. It is suspected that the activity of the inoculant (*Phanerochaete chrysosporium*) which is associated with another so that the degradation process of the lignin fraction is getting lower. Immediately, this does not provide a good value, especially the nutritional aspect of feed produced. Besides that, there are similarities in the value of the lignin content produced in P3 (28.62 %) and P4 (29.28 %) treatments. Therefore, the addition of inoculants up to 20% has not shown maximum results in reducing the lignin content although there has been a decrease when compared to the control treatment. This delignification process begins when *P. chrysosporium* penetrates and forms colonies in wood cells and then secretes enzymes that diffuse through the lumen and cell wall. This fungus attacks the lignin component of the wood to leave cellulose and hemicellulose which are not very influential. As a result, there is a decrease in the physical strength of the wood and swelling the wood tissue (Sigit, 2008). Lignin modifying enzymes (LMEs) are produced by white root fungi during their secondary metabolic process, while lignin oxidation does not provide the fungus with sufficient energy.

CONCLUSIONS

To sum up, research performed that the increasing of inoculants proportion up to 20% during the fermentation process showed the lowering for lignin content.

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