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The Content of Goroho (*Musa Acuminafe, Sp*) Banana Peels' Fiber Fraction Fermented with *Rhizopus Oligosphorus* and *Trichoderma Viride*

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ABSTRACT

The present work seeks to explore the content of cellulose fiber, hemicellulose, and lignin fraction in Goroho (local banana) peels fermented with *Rhizopus oligosphorus* mold and *Trichoderma viride* mold. There were six treatments and four replications in this research: P0, Goroho peels without fermentation (control); P1, Goroho peels fermented with *Rhizopus oligosphorus* 0.3% incubated for 48 hours; P2, Goroho peels fermented with *Trichoderma viride* 0.3% incubated for 120 hours; P3, Goroho peels fermented with *Rhizopus oligosphorus* 0.15% incubated for 48 hours, followed by fermentation in *Trichoderma viride* 0.15% incubated for 120 hours; P4, Goroho peels fermented with *Trichoderma viride*0.15% incubated for 120 hours, followed by fermentation in *Rhizopus oligosphorus*0.15% incubated for 48 hours, and; P5: Goroho peels fermented with *Rhizopus oligosphorus* 0.15% and *Trichoderma viride* 0.15% incubated for 120 hours. The data were examined using a complete randomized design; Duncan's multiple range test was performed if there is a significant difference. Based on the results, the fermentation using the *Rhizopus oligosphorus* and *Trichoderma viride* is impactful towards: a) Lowering in the cellulose content in P1 by 5.56% (from 17.99 to 16.99%); b) Lowering in the hemicellulose content in all treatments, i.e., P1 to P5, best value on P4 by 46.36% (from 27.24 to 14.61%), and; c) There was an increase in the lignin content in all treatments P1 - P5.

INTRODUCTION

One of the success factors of livestock industries is the availability of feed. Animal feeds are of paramount importance in fulfilling the basic needs, supporting growth, and keeping the reproductive system healthy. Concerning livestock production, high nutrition feeds need to be supplied all years—this is a continuous process. During that process, farmers are often troubled with providing quality feeds since it requires a relatively high cost, not to mention the limited supply of such feeds. On that ground, finding alternative feeds with high quality, affordable prices, and in large quantities is essential.

The peels of Goroho (*Musa acuminafe sp*), the local banana, is an example of organic waste with untapped potentials despite its nutrition contents and chemical compositions, e.g., protein (6.4), fat (4.72), crude fiber (17.29), extract materials without nitrogen (55.75), beta carotene (0.61%), and gross energy 5290 kcal/kg (Djunu *et al*., 2020). These nutrient contents make Goroho peels a potential feed. Like other organic waste, Goroho peels contain considerably high crude fiber fractions (e.g., cellulose, hemicellulose, and lignin), making it difficult to turn the peels into animal feed, mainly poultry feed. The peels need to be fermented firstly. Many claim that fermentation can improve nutrient contents, i.e., protein and fat, and reduce crude fiber. Examples of the inoculums that can be used in fermenting the peels are *Rhizopus oligosphorus* and *Trichoderma viride*; both molds can produce cellulases that can degrade crude fiber. The above discussion serves as the rationale to conduct a study focusing on examining the content of cellulose fiber, hemicellulose, and lignin fraction in Goroho banana peels fermented with *Rhizopus oligosphorus* mold and *Trichoderma viride* mold.

MATERIALS AND METHOD

This research was conducted from May to September 2018 at Livestock Laboratory, Universitas Negeri Gorontalo. Materials for the experiment involved:

- Materials: Goroho peel, inoculum*Rhizopus oligosphorus,* and *Trichoderma viride.*
- Tools: fermentation equipment and Van Soest analysis.

The research employed a complete randomized design with six treatments and four replications. The fermentation processes were as follows: P0: Goroho peels without fermentation process (control); a) P1: Goroho peels fermented with *Rhizopus oligosphorus* 0.3% incubated for 48 hours; P2: Goroho peels fermented with *Trichoderma viride* 0.3% incubated for 120 hours; c) P3: Goroho peels fermented with *Rhizopus oligosphorus* 0.15% incubated for 48 hours, followed by fermentation in *Trichoderma viride* 0.15% incubated for 120 hours; d) P4: Goroho peels fermented with *Trichoderma viride* 0.15% incubated for 120 hours, followed by fermentation in *Rhizopus oligosphorus* 0.15% incubated for 48 hours, and; e) P5: Goroho peels fermented with *Rhizopus oligosphorus* 0.15% and *Trichoderma viride* 0.15% incubated for 120 hours.

The fermentation adopted the method by Koni (2013). First, the fresh peels were washed in clean water before being chopped into 5 cm. The cut peels have steamed the temperature of 100^oC around 15 minutes after the water boiled; this process was to kill the pathogen in the peels. Following the steam was to spread the peels in a tray and let them dry and cool. All the peels were mixed with 0.3% of dry material starter until homogenous before wrapped using plastic bags (2 kg capacity). Avoid overfilling the plastic bag as density in the bag, hinders the growth of the mold. The plastics were perforated to allow moisture to escape.

Further, the banana peels were incubated at 30^oC; the durations depended on the time needed for each treatment. The fermented peels removed from the media and dried in an oven at 60^oC for 48 hours to stop the inoculum activities. All dried peels were processed into flour.

Variables of Research

The research variables were the crude fiber fractions of Goroho peel:

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1. Cellulose (%)
2. Hemicellulose (%), and
3. Lignin (%).

DISCUSSION

Provided in Table 1 are of the Van Soest test on the fiber fractions involving cellulose, hemicellulose, and lignin of both unfermented and fermented Goroho peels (with *Rhizopus oligosphorus*and *Trichoderma viride*).

Table 1. The content of cellulose, hemicellulose, and lignin of both unfermented and fermented Goroho peels with *Rhizopus oligosphorus* and *Trichoderma viride*.

Parameter	Treatment					
	P0	P1	P2	P3	P4	P5
Cellulose (%)	17.99[d]	16.99[d]	19.92[c]	24.22[a]	22.15[b]	25.24[a]
Hemicellulose (%)	27.24[a]	25.82[a]	20.11[b]	16.59[c]	14.61[d]	18.05[c]
Lignin (%)	11.66[d]	16.75[c]	19.77[b]	23.83[a]	24.45[a]	16.46[c]

[a,b,c,d,]Different superscripts indicate significant difference ($P < 0.01$).

Content of Cellulose

Cellulose is one of the main constituents of plant cell walls; the compound is a glucose polymer comprising linear chains joined by β-1.4 glycosidic. Goroho peels in treatment P0 to P5 contained 16.99% to 25.24% of cellulose. In treatment 1 (P1), there was a decline in the cellulose content by 5.56% (from 17.99% to 16.99%) due to *Rhizopus oligosphorus* mold activity. This mold is capable of producing phytase and proteases enzyme and cellulase enzyme, as it is classified in the cellulolytic microorganism. The organism functions to degrade cellulose. Another cause is the 24-hour incubation duration of *Rhizopus oligosphorus* that is found effective to degrade cellulose.

During the fermentation in P2 to P5, the cellulose level is increased--it should be noted that the significant rise is in P5. This is more likely due to the cellulose from the two molds used in the fermentation process. *Trichoderma sp* is, by nature, a parasite as it has no chlorophyll. This mold is composed of hypha threads, which are the component of cellulose. During the fermentation, the hypha threads covered the peels, enhancing the cellulose in the fermented materials. Such an increase is also caused by the fact that most molds have cell walls were composed of chitin. Judoamidjoyo *et al*., (1992) find that the increase in cellulose after fermentation is because of the multiplication and growth of mold cells. This situation occurs in P5, in which the growth of the mold is more optimum as the cell walls are composed of cellulose and chitin.The average increase in the cellulose of after fermentation process are 40.30% (from 17.99% to 25.24% in P5), 34,63% (from 17.99% to 24.22% in P3), 23.12% (from 17.99% to 22.15% in P4), and 10.73% (from 17.99% to 19.92% in P2).

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Content of Hemicellulose

A hemicellulose is a group of heterogeneous polysaccharides with low molecular weight. This compound is relatively easy to hydrolyze with acids whose monomers are composed of mannose, glucose, galactose, xylose, and arabinose. Table 1 shows the hemicellulose content of Goroho peels fermented with 14.61% to 27.24% of *Rhizopus oligosphorus* and *Trichoderma viride*. There was a decline in the hemicellulose content in all treatments P1 - P5 on average.

Such a drop is caused by stretching in lignohemicellulose bonds that facilitate the penetration of the hemicellulases produced by *Rhizopus oligosphorus* and *Trichoderma viride* to degrade hemicellulose; molds use the products of such a process as an energy source. Perez *et al*., (2002) assert that the hemicellulases enable the hemicellulose fractions to degrade into sugar monomers and acetic acid. Treatment P4 has optimum abilities in degrading hemicellulose; this is seen in the drop by 46.36% in the hemicellulose content (from 27.24% to 14.61%). A longer incubation duration causes such a result, i.e., 120 hours for the incubation of *Trichoderma viride*, followed by the 48-hour incubation of *Rhizopus oligosphorus*. Compared to other fiber fractions, hemicellulose has higher digestibility (Van Soest, 1982). There is 15 to 30% of hemicellulose of the total dry weight of lignocellulose (Taherzadeh, 1999).

The average increases in the hemicellulose of the peels after fermentation process using *Rhizopus oligosphorus* and *Trichoderma viride* are 5.21% (from 27.24% to 25.82% in P1), 26,17% (from 27.24% to 20.11% in P2), 33.73% (from 27.24% to 18.05% in P5), 39,09% (from 27,24 to 16,59% in P3), and 46.36% (from 27.24% to 14.61% in P4).

Content of Lignin

Lignin is a polymer chain whose aromatic structures are formed by phenyl propane units (Sjorberg, 2003) connected with different bondings (Perez *et al*., 2002). Further, lignin plays a significant role in strengthening plant structures, enhancing its durability against oxidative stress and microbe attack (Hendriks and Zeeman, 2009). Lignin is an amorphous heteropolymer consisting of three different phenylpropane, namely p-coumaryl (H), coniferyl (G), and sinapyl (S). All of these components are bounded with different bonds. The present study results revealed that the lignin content in the banana peels P0 to P5 ranges from 11.66 to 24.45%. The average lignin content is higher than the control group; the treatment with the highest lignin to the lowest, in the respective order, is P4: 24.45; P3: 23.83; P2: 19.77; P1: 16.75; P5: 16.46, and P0: 11.66%.

In fermented Goroho peels, lignin's content increases due to the low ability of *Rhizopus oligosphorus* and *Trichoderma viride* in degrading lignin through the activity of produced enzymes. This is more likely because of the lack of enzymes capable of degrading lignin, such as lignase, lignin peroxidase, manganese peroxidase, and laccase. Another contributing factor is correlated with cellulose content—which relatively increases—as lignin is bound with cellulose. Lignin fractions of the molds are hard to degrade, given their complex characteristics bound to hemicellulose and cellulose in plant tissue structure. There are more than 30% of lignin in a

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plant's cell walls with a sturdy structure functioning to protect the plant against pathogenic insects (Orth *et al*., 1993). Another consideration is the contribution of cell walls from the two molds used in the fermentation process.

The average increase in the cellulose of banana peels after fermentation process using *Rhizopus oligosphorus* and *Trichoderma viride* are 109.69% (from 11.66% to 24.45% in P4), 104,37% (from 11.66% to 23.83% in P3), 69.55% (from 11.66% to 19.77% in P2), 43.65% (from 11.66% to 16.75%, P1), and 41.16% (from 11.66% to 16.46% in P5).

CONCLUSION

Based on the results, the fermentation using the *Rhizopus oligosphorus* and *Trichoderma viride* is impactful towards:

1. Lowering in the cellulose content in P1 by 5.56% (from 17.99 to 16.99%).
2. Lowering in the hemicellulose content in all treatments, i.e., P1 to P5 by 46.36% (from 27.24 to 14.61%).
3. An increase in the lignin content in all treatments P1 - P5.

REFERENCES

[1]. Djunu. S. S., S. Chuzaemi., I. H. Djunaidi., M. H. Natsir. 2020. Nutritional Value Evaluation of Goroho Banana Skin (*Musa acuminafe*, *sp*) as Animal Feed by Fermentation with *Rhizopus oligosphorus* and *Trichoderma viride*. International Journal of Agriculture and Biological Sciences. Vol 4. 7-14.

[2]. Hendriks, A. T. W. M, and G. Zeeman. 2009. Treatmen to Enchange the Digestibility of Lignocellulose Biomass. Biores Technol. (8): 10-18.

[3]. Judoamidjoyo., M. darwis., and G. E. Said. 1992. Teknologi Fermentasi [Fermentation Technology]. Rajawali Press. Jakarta.

[4]. Orth A.B., D.J. Royse, M. Tien. 1993. Ubiquity ol Lignin Degrading Peroxidases Among Various Wood-Degrading Fungi. Appl Environ Mcrobiol. 59: 4017-4023.

[5]. Perez, J., J. M. Dorado., T. Rubia., J. Martinez. 2002. Biodegradation and Biological Treatments of Cellulose, Hemicellulose and Lignin: An Overview. Int. Microbiol. 5. 53-63.

[6]. Sjoberg, G. 2003. Lignin Degredation: Long-Term Effects of Nitrogen Adition on Decomposition of Forest Soil Organic Matter. Disertasi. Uppsala: Dep. Soil Sci. Swedish University of Agricultural Sciences.

[7]. Taherzadeh, M. J. 1999. Etthanol From Lignocellulose: Physiological Effects of Inhibitors and Fermentation Strategies.

[8]. Van Soest, P. J. 1982. Nutrional Ecology of The Ruminant: Ruminant Metabolism. Nutrional Strategies The Cellulolytic Fermentation and The Chemistry of Foragesand Plant Fibers. Cornell University O & B Books Inc. USA.