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Preface

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Preface

We are proud to inform you that the **International Conference on Sustainable Agriculture, Food, and Energy (SAFE2019): Green Agri-food Energy Production for a Better World in a Changing Climate**” which will be held from October 18-21, 2019 in Phuket, Thailand. The co-host institution is Chiang Mai University, Thailand, Chiang Mai Rajabht University, THAILAND and ANDALAS University, INDONESIA. This conference is the 7th conference after the 1st International Conference on Sustainable Agriculture, Food, and Energy (SAFE2013) in Padang, Indonesia (12-14 May 2014), the 2nd conference [SAFE2014](#) in Bali, Indonesia (17-19 September 2014). The 3rd conference [SAFE2015](#) in Ho Chi Minh City, Vietnam (17-19 November 2015), 4th conference [SAFE2016](#), Colombo, Sri Lanka (October 20-22, 2016), the 5th conference [SAFE2017](#), Malaysia, August 22-24, 2017. and the 6th conference of [SAFE2018](#), Manila, Philippines [October 19-21, 2018].

The objectives of the conference were:

To provide a forum for international researchers community to exchange and share the experiences, new ideas, sustainability concepts and research results on sustainable agriculture, food, and energy.

To promote collaboration in research on sustainable agriculture, foods, and energy production. To establish a regional networking among participants on sustainable agriculture, food, and energy.

To increase awareness of the importance of living and working in the manner that enhances the economic, environmental and social well-being of our community through research, education, regional partnerships, and community engagement.

The committee accepted 90 papers of over 300 papers which were presented in SAFE2019 conference.

On behalf of SAFE-Network, we would like to convey our appreciation and thanks very much to Chiang Mai University, Chiang Mai Rajabhat University, and the Phuket Rajabhat University, Phuket. Thailand

We would like especially to thank **Prof. Dr. Tafdil Husni**, *Rector of Andalas University* for his strong support to this event, **Dr. Sermkiat Jenjunyong**, *local conference coordinator* and the members of the local organizing committee who helped with all the preparations required to make the conference a success, as well as the session organizers who worked to ensure a high level of science presented at the meeting. Moreover, of course, we thank all honorable speakers and participants who have agreed to attend and discuss your work! Finally, please understand that while every effort was made to publish this proceeding, we know that unavoidable withdrawals and other changes will occur.

Looking forward to welcoming you to the SAFE2020 conference in Jeju, Korea!

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Effect Fermentation of Sugarcane Shoots With Phanerochaetechrysosporium on the Activity of Lacase Enzymes, Lignin Peroxidase and Manganese Peroxidase

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Effect Fermentation of Sugarcane Shoots With *Phanerochaetechrysosporium* on the Activity of Lacase Enzymes, Lignin Peroxidase and Manganese Peroxidase

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Abstract. Sugarcane shoots are very potential for make feed because there are quite a lot of them. Efforts to use sugarcane shoots by products have been carried out but it is still not optimal. One strategy that can be done is to use it as fermented feed. Main constraints on use of sugarcane shoots for animal feed are nutritional value, low digestibility and high lignin. Lignin physically and chemically is a major factor in the inability of livestock to digest feed ingredients. Fungi that have the ability to degrade high lignin are fungi which are included in the white rot fungi. One of them is *Phanerochaetechrysosporium* which is known to produce enzyme lignin peroxidase (LiP), manganese peroxidase (MnP) and lacase. *Phanerochaetechrysosporium* is one of the fungi could break down the bonds and degradate lignin with the help of lignin degrading enzymes. In this study sugarcane shoots were fermented using *Phanerochaetechrysosporium*. This method study used Completely Randomized Design (CRD) with 4 treatments inoculum dose A (0%), B (5%), C (10%), D (15%) with 5 replications. Data processing by analysis of variance (ANOVA), if it was significantly different in further testing with DMRT. Results showed that treatment C (10%) was the best dose that could be used with the production of lacase enzyme activity 2.016 U / ml, Lignin Peroxidase (LiP) 1.677 U / ml and Manganese peroxidase (MnP) 0.328 U / ml.

1. Introduction

Indonesia is agriculture country has most variety of agricultural side products. Sugarcane is one of strategic agricultural commodities to provide many side products from both on farm and off farm. Largest area of sugarcane plantation in 2010 was 418,259 ha with national sugarcane production 34,218,549 tons [1]. Sugarcane waste produced from this area will reach 17,793,645 tons [2].

One of the side products of sugarcane is sugarcane shoots, very potential used for feed cause the amount is quite large. Efforts to use sugarcane by products have been carried out but it is still not optimal. This requires an appropriate technology approach to further increase added value of sugarcane shoots. One strategy that can be done is to use it as fermented feed. Main constraints on the use of sugarcane shoots for animal feed are nutritional value, low digestibility and high lignin. Lignin physically and chemically is a major factor inability of livestock has digest feed ingredients. Lignin is chemically bound to structural carbohydrate components and physically acts as a barrier to the process of reforming cell walls by rumen microbes[2].

Some microbes could act as decomposers in fermented feed are fungi, yeast and bacteria. One of fungi type has the ability degradation high lignin which as fungi included in white rot fungi. These



fungi call Phanerochaetechrysosporium, known to produce the enzyme lignin peroxidase (LiP), manganese peroxidase (MnP) and lacase. Phanerochaetechrysosporium is one of the fungi can break down the bonds and degradate lignin with help of lignin degrading enzymes. This fungi also degrades cellulose, hemicellulose and lignin polymers with the help of extracellular enzymes. Biodegradation is the process of changing substrate by microorganisms involving a number of reactions into simpler products. Activities of overhauling the substrate component requires nutrients obtained from the results of reshuffle.[3]

Lignin peroxidase (LiP) and manganese peroxidase (MnP) are extracellular peroxidase enzymes that use H₂O₂ to degrade lignin, whereas lacase is a copper-containing enzyme using oxygen molecules to degrade lignin [4]. According to Ref. [5], enzyme work is influenced by several factors, namely substrate, temperature, pH, cofactor and inhibitor. Use of sugarcane shoots as microbial substrate will increase the nutritional value of sugarcane shoots. In this study sugarcane shoots were fermented using Phanerochaetechrysosporium with different doses and the same incubation period. Based on the analysis of the dose of the inoculum it affected the activity of the lacase enzyme, lignin peroxidase (LiP) and manganese peroxidase (MnP).

2. Material and Methods

2.1. Material

This research was conducted at the Feed Industry Technology Laboratory of the Faculty of Animal Husbandry, Andalas University. The materials used in this study were Phanerochaetechrysosporium and sugarcane shoots. The equipment used in this study was 1700 Shimadzu UV-Vis Spectrophotometer, autoclave, measuring tube, test tube, electric stove, colony counter, micro pipette, electric heater, and a set of glass tools.

2.1.1. Preparation of Phanerochaetechrysosporium Inoculum

Phanerochaetechrysosporium isolate was rejuvenated on PDA sloping media, incubated at 30 oC for 7 days. Sterilize 100 grams of sugar cane which has been added to distilled water up to 60%. Autoclave for 30 minutes at 121oC, after being warm mixed with 1 test tube, isolates of Phanerochaetechrysosporium. Incubation for seven days.

2.1.2. Fermentation of sugarcane shoots with Phanerochaetechrysosporium

As much 100 grams of sugarcane mashed, distilled water to 60% moisture content, sterilize in an autoclave for 30 minutes. Added inoculum Phanerochaetechrysosporium as much as 0%, 5%, 10% and 15% then incubated for 21 days.

2.1.3. Test Activity of Lignin Peroxidase (LiP) Enzymes (Tien & Kirk, 1984)[6]

0.2 ml of enzyme filtrate, 0.05 ml of H₂O₂ 5 mM; 0.1 ml of veratril alcohol 8 mM; 0.2 ml of acetate buffer 0.05 M pH 3 and 0.45 ml of distilled water are added to cuvette and then shaken. Solution was read the absorbance at a wavelength of 310 nm at 0 and 30 minute intervals. One unit of enzyme activity in LiP is defined as amount of enzyme that causes conversion of 1 micromol (1 μmol = 10⁻⁶ mol) veratril alcohol per minute.

2.1.4. Test the Activity of Manganese Peroxidase (MnP) Enzymes (Wariishi, Valli & Gold, 1962) [7]

As much as 0.1 ml of 50 mM Na-lactate buffer pH 5 is added with 0.1 ml of 4 mM guaiacol, 0.2 ml of MnSO₄ 1 mM, 0.1 ml of H₂O₂ 1 mM and distilled water 0.3 ml then 0.2 filtrate is added enzyme. Solution was then checked and read at a wavelength of 465 nm in the 0 and 30 minutes.

2.1.5. Test the Activity of Lakase Enzymes (Leonowicz & Grzywnowicz, 1981) [8]

As much as 0.4 ml of enzyme filtrate plus 0.5 ml pH 5 acetate buffer of 0.5 ml and 0.1 ml of 1 mM ABTS. then it was checked and measurements were read 420 nm wavelength. Reading is done in the 0 and 30 minutes.

2.2. Research Methode

2.2.1. Analysis of Statistic (Steel and Torrie , 1960) [9]

This experiment by completely randomized design (CRD) with 4 treatments, namely inoculum doses A (0%), B (5%), C (10%), D (15%) with 5 replications. Data processing used analysis of variance (ANOVA). If got significantly different in further testing with DMRT.

3. Result and Discussions

This below results of the analysis of the activity of the lacase enzyme, lignin peroxidase (LiP) and Manganese peroxidase (MnP) are presented in Table 1.

Table 1. Results of measurement of activity of Lacase enzyme, Lignin peroxidase (LiP) and Manganese peroxidase (MnP) fermented sugarcane shoots

Treatment	Enzym Activity (U/ml)		
	Lacase	LiP	MnP
A (0 %)	0.505d ± 0.09	1.153 c± 0.03	0.030d ± 0.01
B (5 %)	1.213c ± 0.17	1.464 b± 0.04	0.107b ± 0.01
C (10%)	2.016a ± 0.10	1.677 a± 0.06	0.328a ± 0.04
D (15 %)	1.663b ± 0.06	1.413 b± 0.04	0.129b ± 0.04

Note: Different letters in the same column show a significant difference based on the DMRT test at the 5% real level

According Table 1 results of the lacase enzyme activity test showed that at a dose of 10% (C) the highest value was 1,213 U/ml. ANOVA observations for lacase activity showed that different inoculum doses showed a significant difference with the same incubation period of 21 days. At doses of 0%, 5% and 10% the activity has increased by 0.505 U/ml, 1.213 U/ml and 2.016 U / ml, respectively. At a dose of 15% (D) activity decreases, this occurs because the number of fungi is more than the availability of substrate nutrients. According to Supriyanto (2009) [5],

Enzyme work is influenced by several factors, namely substrate, temperature, pH, cofactor and inhibitor. The highest test results for Lignin peroxidase (LiP) enzyme activity were found at 10% (C) inoculum dose of 1.677 U / ml. Overall the activity of lignin peroxidase is higher than that of lacase activity. From the data produced with higher doses it does not always provide higher activities results. In treatment D (15%) with same period of incubation Lignin peroxidase (LiP) activity decreased to 1,663 U / ml. Lignin peroxidase (LiP) is produced by *Phanerochaetechrysosporium* to break C-C or C-O-C bonds in aromatic non-phenolic chains of substrates with fast The degraded substrate will be more easily utilized by the *Phanerochaetechrysosporium* for its growth (Wong, 2009; Pogni et al, 2007) [9] [10]

Manganese peroxidase (MnP) activity test results showed the lowest value compared to lacase and Lignin peroxidase (LiP). The largest manganese peroxidase (MnP) activity in treatment D (10%) is 0.328 U / ml, higher than doses A (0%) and B (5%), which are 0.030 U / ml and 0.107 U / ml respectively and decrease in treatment D (15%) which is 0.129 U / ml. Lignolytic enzyme activity is influenced by pH, substrate concentration, temperature, amount of nitrogen, and supporting minerals (Patel et al., 2009).[11]. Ergun et al (2015) [12] showed that MnP activity value would be relatively stable at the incubation period of 50 days. The enzyme has an optimum activity at a certain pH which is also called the optimum pH. The role of the enzyme in catalyzing a reaction depends on the type of specific substrate.

4. Conclusion

Based the results of the study could concluded that sugarcane shoot fermentation with mold *Phanerochaetechrysosporium* produces the highest enzyme activity at a dose of 10% with a 21-day incubation period. Lacase activity was 2.016 U / ml, Lignin Peroxidase (LiP) 1.677 U / ml and Manganese peroxidase (MnP) 0.328 U

References

- [1] Ditjenbun. 2011. National sugar self-sufficiency. Sugar cane technical guidance. Directorate Seasonal Plants, Directorate General of Plantations. Jakarta.
- [2] Murni, R., S. Akmal, dan B.L. Ginting. 2008. Textbooks on the use of waste technology for feed. Jambi University, Jambi
- [3] Imsya, A. Laconi, E. B. Wiryawan, K., G. Widyastutu, Y. (2014). Biodegradation of Lignocellulose with *Phanerochaete chrysosporium* on Changes in Palm Nutrition Value. *Sriwijaya Animal Husbandry Journal*. Vol.3 No 2. Pp. 12-19. ISSN 2302-1039.
- [4] A. Hattaka, "Modifying Enzymes from Selected White-Rot Fungi: Production and Role in Lignin Degradation," *Microbiology*, Vol. 13(1994) 125-135.
- [5] Supriyanto, A. Benefits of *Phanerochaete chrysosporium* L1 and *Pleurotus Eb9* White Fungal for Biobleaching of Used Cardboard Pulp, [Thesis] Bogor Agricultural Institute.
- [6] Tien, M & Kirk, T.K., 1984. Lignin-degrading enzyme from *Phanerochaete chrysosporium*: Purification, characterization and catalytic properties of a unique H₂O₂-requiring oxygenase. *Proceedings of the national Academy of Science of the United States of America*, pp.2280-2284.
- [7] Leonowicz, A. & Grzywnowicz, K., 1981. Quantitative estimation of laccase forms in some white-rot fungi using syringaldazine as a substrate. *Enzyme and Microbial Technology*, 3(1). Pp. 55-58
- [8] Wariishi, H., Valli, K., Gold, M.H., 1992. Manganese (II) oxidation by manganese peroxidase from the Basidiomycetes: kinetic mechanism and role of chelators. *J. Biol. Chem.* 267, 23688-23695
- [9] Steel, R. G. D., and J. H. Torrie: *Principles and Procedures of Statistics. (With special Reference to the Biological Sciences.)* McGraw-Hill Book Company, New York, Toronto, London 1960
- [9]. Wong, D.W (2009). Structure and action mechanism of lignolytic enzymes, *Applied Biochemistry and Biotechnology* 174-209.
- [10] Pogni, R. Brogioni. B., Baratto, M. C., Sinicropi, A., Giardina, P., pezzela, C., Sania, G. and Basosi, R. 2007. Evidence for a radical mechanism in biocatalytic degradation of synthetic dyes by fungal laccases mediated by violuric acid. *Biocatalysis and Biotransformation*, pp. 267-275
- [11]. Patel H, AGuptc & S Gupta (2009). Effect of different culture conditions and inducers on production of laccase by Basidiomycetes fungal isolate *Pleurotus ostreatus* HP-1 under solid state fermentation. *Bioresource* 4(1), 268-284
- [12]. Ergun SO & RO Urek (2017). Production of lignolytic enzymes by solid state fermentation using *Pleurotus ostreatus*, *Annals of Agrarian Science* 15, 237-277.

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