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The Effect of Cocoa Pods Waste as a Growing Media Supplement on Productivity and Nutrient Content of Brown Oyster Mushroom (*Pleurotus cystidiosus*)

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Abstract
The development of the plantation sector have increased impact of waste of which wood sawdust and cocoa pods wastes. These wastes have the potential to become environmental problems if not treated, but it would be beneficial if it is used as a growing media supplement on oyster mushroom cultivation. The study aims to analyze and assess the effect of the cocoa pods waste as a growing media supplement on productivity and nutrient content of brown oyster mushroom (Pleurotus cystidiosus) has been carried out using a completely randomized design (CRD) with 4 kinds of treatment comparisons sawdust and cocoa pods waste, ie SC_0 (100% sawdust and 0% cocoa pods waste)/control, SC_1 (80% sawdust and 20% cocoa pods waste), SC_2 (75% sawdust and 25% cocoa pods waste) and SC_3 (70% sawdust and 30% cocoa pods waste). The research data has analyzed by one-way anova and followed-Duncan's at 5%. The results showed that the use of cocoa pods waste by comparison ratio 75% sawdust and 25% cocoa pods waste (SC_2) is the best on production and nutrition content of brown oyster mushrooms, and recommended to be applied in the cultivation of oyster mushroom brown.
Keywords: brown oyster mushrooms, cocoa pods waste, productivity, nutritions content, growing media supplement

1. Introduction

In Indonesia, oyster mushrooms are widely known by mushroom growers, one brown oyster mushroom (*Pleurotus cystidiosus*). These fungi can be grown on sawdust, rice straw, rice husk, cotton waste, waste tea leaves, corn husks, waste paper, and other lignocellulosic materials. Brown oyster mushrooms have special characteristics that can be recognized easily include forms such as oysters caps 4-15cm in diameter or more. Caps rather greasy surface slippery when moist, white hood color brownish or sometimes yellowish brown when mature mushrooms, but rolled into the caps and often curved in young mushrooms.

The Oyster mushroom cultivation should be developed in various ways, one of which is to vary the growth media in a way to provide additional organic material other than sawdust. Medium fortified with additional nutrients is expected to increase the productivity and nutrient content of oyster mushrooms. One important factor in the cultivation of oyster mushroom, is the availability of the substrate as a growing medium. Levels of nutrients contained in the mold depends on the type and substrate or a place to grow mushrooms.

Jember district of East Java, Indonesia is geographically based on agriculture, especially plantation and expand to agribusiness. Cocoa plants potentially in grow plantation area at Jember. The development of the plantation sector have the effect to impact of the wood sawdust waste and cocoa pods waste. That wastes will become the environmental problems if without treatment the cocoa pods waste is accumulated at the plantation for a few months, so it cause a bad smell and liquid that contaminate the environment, and it is important to use the waste for the of the oyster mushroom growing media.

Oyster mushrooms is sort of mushroom that can be cultivated easily, because this mushroom have a good adaptability, so it can grow in various of substrate. Therefore, the oyster mushrooms have cultivated by using some sort of agricultural and industrial wastes as the substrate supplement (Zervakis and Balis, 1991).

One of the important factors that play a role in oyster mushroom cultivation, is the appropriate substrate as a growing media. The nutrients contents the mushroom is depends on the substrate sort to grow the mushrooms. The mushroom need nutrients in the form of chemical elements for their growth such as Nitrogen, Phosphorus, sulphur, Potassium and carbon which have been available in the wood as the substrate, but the number is not sufficient.

The cocoa pods has a high content of organic material and quite varies. According to Shepherd and Ngan (1986), organic matter content in the cocoa pods is N 16.6 kg /tons P_2O_5 1.7 kg /tons, K_2O 55.4 kg /tons, MgO 3.0 kg/tons and 2.3 kg CaO /tons. Organic matter content in dry cocoa pods is a dry matteris 90.4 %, 16.4 % ash, 6.0 % crude protein, 31.5% crude fiber, 1.5% crude fat, N-free extract 4.52 %, 0.9 % ether extract, 0.67 % Ca, 0.10% P, 0.64 % Mg, energy 3.51 kcal /g, and the energy is 2.10 kcal/g.

The substrates used in the oyster mushroom cultivation at the USA are wheat straw or cotton seed hulls or a mixture of both. The composition or the ratio of substrates used in the cultivation of mushrooms is generally a mixture of 70 % cotton seed hulls, 24% rice straw and 1% lime (Royse, 2003).

Pleurotus eryngii was cultivated successfully in many agricultural wastes and agricultural industry range includes sawdust, wheat straw, cotton waste, wheat, millet straw, rice straw and soybeans (Cangy and Peerally, 1995; Zervakis et al., 2001; Kirbag & Akyuz, 2008). Prakash, et al (2010) reported that 4% humic acid application is need to obtain maximum yields. The nutritional value of mushrooms is reach 0.4 g protein, 0.1g fat, and 19.5% fiber. The optimum substrate composition also showed a significant effect on productivity and Biological Efficiency (*BE*), the value are 18.47% and 27.16%.

The study aims to analyze and assess the effect of cocoa pods waste as planting media on productivity and nutrient content of brown oyster mushroom (*Pleurotus cystidiosus*) are expected to have the benefit of which is to reduce and provide troubleshooting of industrial wastes such as sawdust sawmill waste wood and cocoa pods waste and creating added value through the brown oyster mushroom cultivation, and produced an exact comparison planting medium with a mixture of sawdust and cocoa pod waste in an effort to increase production and nutrient content quality of oyster mushrooms.

2. Material and Methods

The research was conducted at "MITRA JAMUR" Jember East Java, Indonesia. The materials used is this research among others, brown oyster mushroom spawm, sowdust, cocoa pods wastes and chemicals for nutrient content analysis. The research design is a completely randomized design (CRD) with 4 sort treatments and 4 replications as follow:

1. SC_0 is comparisons of 100% sawdust: 0% wastes plantation)/control
2. SC_1 is comparisons of 80% sawdust: 20% cocoa pods wastes.
3. SC_2 is comparisons of 75% sawdust: 25% cocoa pods wastes.
4. SC_3 is comparisons of 70% sawdust: 30% cocoa pods wastes.

The statistical models for this research is:

$\gamma_{ij} = \mu + \tau_i + \varepsilon_{ij}$

$_i = 1, 2, \ldots\ldots$ect

$j = 1, 2, \ldots\ldots$ ect

Where: γ_{ij} = value of observation on the treatmen to-i replicates to-j

μ = the value of the common central

τ_i = effect of the treatment to-i

ε_{ij} = error to the trial on treatment to I replicates to-j

Analysis of the data used was one-way anova, and when there is a significant difference in treatment then continued with a test average difference between treatment with Duncan's at 5% (Gomez & Gomez. 1995). data were processed using SPSS software version 17.0.

The parameters observed in this research include productivity and nutritional parameters also nutrient growth media of oyster mushrooms:

a. Productivity of oyster mushroom that are 1) number of fruit body is calculated whole fruit body both large and small size category. 2) diameter caps, measured sample has a diameter of the largest fruit body cap. 3) production weight of fruit body, measured by weighing the weight (g) of each unit in the replicates for each treatment. 4) biological efficiency (BE) which demonstrates the ability of the substrate to produce a unit weight unit of fruiting bodies mushroom, ie comparison of the body fruit weight of each weighing baglog multiplied by 100%.
b. Nutrient content Oyster mushrooms are : 1) proteins were analyzed by semi-micro Kjeldhal method. 2) fat ware analyzed by the Soxchlet method. 3) carbohydrate analyzed by the Luff Schoorl method. 4) fibers were analyzed by the Neutral Detergent Fiber (NDF) method.
c. Nutrients content of the growing media are: 1) Nitrogen total were analyzed by micro-Kjeldhal method, 2) P_2O_5 were analyzed by Bray I method, 3) K_2O were analyzed by Flamephotometer or AAS method, and 4) C-organic were analyzed by Walkley and Black method.

3. Results and Discussion

3.1 Morphological characteristics of brown oyster mushroom

The brown oyster mushroom harvesting is done by holding the stalk of fruiting bodies then play it up regardless of the substrate. Harvesting is done every day in the morning and evening. Oyster mushrooms have brown fruiting bodies thicker hood and caps edges curved with a longer stalk body as shown in Figure 1 as follows.

Figure 1. Structure morphology of brown oyster mushroom with Edge curved caps

Based on the observation of morphological characters showed that the oyster mushroom fruiting bodies are generally brown in color, grown in clusters at the edge of the curved caps, more can be seen in Table 1.

Table 1**:** Morphological characteristics of *P. cystidiosus* fruit bodies mushroom

Item	Description
Fruit occurrence	Grown in clusters (2-6) fruit bodies together), sometimes Grown individually.
Cap color	Brown
Cap shape	Edge curved caps with brown long gills.
Cap diameter	5 – 18 cm.
Stem color	Brown
Stem shape	Thick cylindrical, more thick at the top, while less at the bottom (tapering down ward).
Stem dimensions	4 – 12 cm in length , while diameter vary from 0.5 - 1.0 cm. at bottom to 1.0 - 2.0 cm at top.
verage fruit body weight	*15* – 18 g.

3.2 Brown Oyster Mushroom Productivity

Productivityis the achievement of the oyster mushroom harvest in oyster mushroom cultivation, the productivity can be measured from the constituent components of production which includes the total number fruit body,caps diameter, production weight and *BE*.

The anova analysis results for the effects of the cocoa pods waste and as a growing media supplement treatment showed a significant effect on the number of fruiting bodies , caps diameter, production weight, and *BE* of the brown oyster mushrooms with a significance of all parameter values below 0.05 (sig. <0.05).

Based on 5% Duncan's showed that the addition of sewage treatment rind cocoa in contrast to the control of the number of fruiting bodies, caps diameter, weight and production of brown oyster mushroom *BE*, Showed in Table 2 and figure 2 as follows.

Table 2. Data of number of fruit body, caps diameter, production weight and *BE* brown oyster mushroom on cocoa pods wastes treatment.

Comparison of WasteTreatment (SC)	Observations type*)			
	Number Fruiting bodies (unit)	Caps diameter (cm)	Weight Production (g)	BE (%)
SC_0 (100% : 0%)	23,44 [a]	12,09 [a]	405,75 [a]	50,09 [a]
SC_1 (80% : 20%)	31,19 [bc]	13,02 [abc]	500,44 [b]	59,58[b]
SC_2 (75% : 25%)	32,44 [c]	13,41 [c]	561,06 [c]	64,49 [c]
SC_3 (70% : 30%)	30,44 [bc]	12,83 [abc]	566,94 [c]	64,06[c]

Description:

*) The numbers which are accompanied by the same notation in the same column are not significantly different at Duncan's 5%.

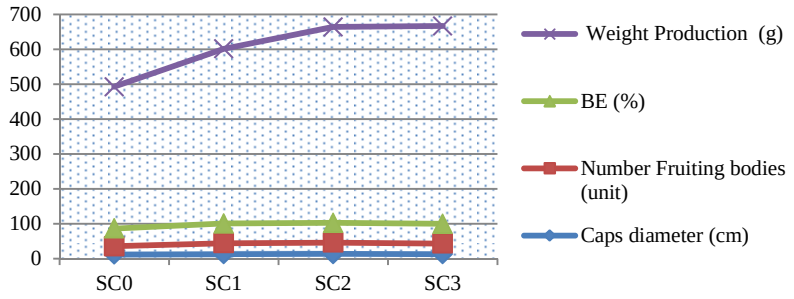

Figure 2. Graphic of the cocoa pods wastes treatment on of number of fruit body, caps diameter, production weight and *BE*.

The highest number of fruiting bodies in the cocoa pods waste treatment in comparison of SC_2 is 32.44 units. The highest caps diameter on the cocoa pods waste treatment in comparison of SC_2 is 13.41 cm. The highest production weight on the cocoa pods waste treatment in comparison of SC_3 is 566.94 g. The highest *BE* value in the treatment of cocoa pods waste in comparison of SC_2 is 64.49.

The addition of cocoa pods wastes as a supplement of growing media used to add nutrients that are not present in the sawdust that can increase the oyster mushroom growth optimally. The oyster mushrooms take the nutrients for growth and development. During of oyster mushrooms growth take the carbon as a basic element of cells and source of energy required by mushroom cells. All carbon compounds can be used by oyster mushrooms such as monosaccharides, polysaccharides, organic acids, amino acids, cellulose and lignin. An increasing number of fruiting bodies is due to the addition of cocoa pods waste, so the nutrient content of the substrate or growing media would be increases (seen in Table 4).

The growth and development of the mushroom requires nutrients in the form of chemical elements such as Nitrogen, Phosphorus, Sulphur, Potassium and carbon which has been available in wood tissues, although in small amounts. Therefore, the addition of external nutrient for example in the form of fertilizer that is used as an ingredient for mushroom substrate or growing medium needs to be done. The cocoa pods also contains a plenty of fiber approximately 65.20 % that it contains cellulose and lignin, these compounds are organic materials needed for the growth of the oyster mushrooms. Furthermore reported the addition of N, P, K fertilizer in the planting medium with a dose of 1 kg/100 kg of media materials is the optimum dose to increase the total number of fruit body of the oyster mushroom is 77 units and the total weight of the oyster mushroom fruit body production is 282.161 g (Mudakir, 2010).

The addition of cocoa pods waste can increase the nitrogen content in the substrate due to the mineral nutrient content of the cocoa pods is high enough, especially potassium and nitrogen nutrients. reported that 61% of the total are nutrients are stored in the cocoa pods. Nutrient content of compost made from cocoa pods is 1.81% nitrogen. Application of compost made from cocoa pods can increase production up to 19.48 % (Baon et al, 2005).

Furthermore, reported results of research with the addition of the coffee fruit pods waste impact in improving the growth and production of white oyster mushroom production with increased weight of 405.79 g and the amount of fruit body production of 90.84 units (Asyiah et al, 2011).

The addition of cocoa pods waste can increase C-organic in the substrate. The requirement of carbon of oyster mushrooms from carbohydrates sourced as a basic element formation and energy for cell metabolism. Carbon source is obtained in the form of monosaccharides, polysaccharides, cellulose and lignin (wood). Nutrient content of compost made from cocoa pods is 26.61 % C-organic (Baon et al. 2005).

The addition of cocoa pods wastes in the substrate, in general there is a tendency of increase in the content of total Nitrogen, P_2O_5, K_2O, C-organic and CN ratio, this is what causes the increase in weight of the total production weight of oyster mushroom. The substrate is a major nutrient source for the mushroom. Nutrients can be utilized after the mushroom excrete extracellular enzymes that can break down complex compounds of a particular substrate compounds into simpler compounds (Gandjar, et. al, 2006). The higher the *BE* value, the better the mushroom cultivation. While the *BE* value is used to describe the value of the conversion of lignocellulosic materials into the mushroom fruit bodies. Furthermore, the optimum substrate composition also showed a significant effect on *BE*.

3.4 Nutrients Content of Brown Oyster Mushroom

Analysis of the nutritional content of the mushrooms with the proximate analysis is a method of chemical analysis to identify the nutrients like proteins, carbohydrates and fats to a substance (Sudarmadji, et al, 1989).

Based on anova showed that the treatment cocoa pods wastes have a significant effect on protein, fat,

carbohydrate, and fiber oyster mushroom with a significance of all parameter values below 0.05 (sig. <0.05). Based on Duncan's 5 % showed that the addition of sewage treatment rind cocoa in contrast to the control of protein, fat, carbohydrate and fiber oyster mushroom. Showed in Table 3 and figure 3 as follows.

Table 3. Data of Protein, Fat, carbohydrates and Fiber content in Brown Oyster Mushroom on Cocoa pods Wastes Treatment.

Comparison of WasteTreatment (SC)	Observations type*)			
	Protein Content (%)	Fat Content (%)	Carbohydrate Content (%)	Fiber Content (%)
SC_0 (100% : 0%)	1,59 [a]	0,04 [a]	5,37 [a]	2,28 [a]
SC_1 (80% : 20%)	1,62 [a]	0,04 [a]	5,65 [c]	2,79 [b]
SC_2 (75% : 25%)	2,08 [b]	0,05 [b]	6,16 [b]	3,28 [cd]
SC_3 (70% : 30%)	2,71 [c]	0,04 [a]	7,78 [d]	3,56 [d]

Description:

*) The numbers are accompanied by the same notation in the same column are not significantly different at Duncan's 5%.

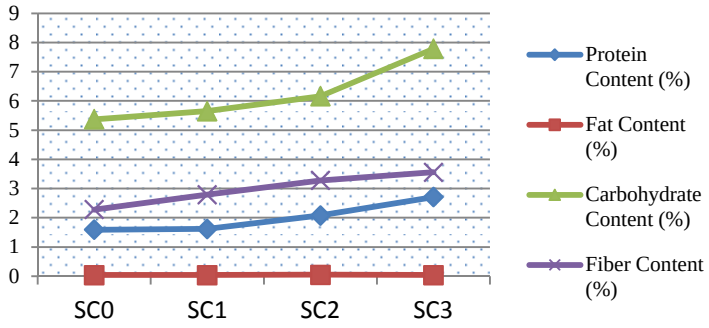

Figure 3. Graphic of the cocoa pods wastes treatment on protein, fat, carbohydrates and fiber content.

The addition of cocoa pods waste have a tendency to increase the protein, carbohydrates and fiber also the fat content in brown oyster mushrooms. The highest protein content in addition to the cocoa pods in comparison of SC_3 is 2.71 %. The highest fat content is in cocoa pods treatment in comparison of SC_2 is 0.05 %. The highest carbohydrates content is in the cocoa pods treatment in comparison of SC_3 is 7.78 %. The highest fiber content of the cocoa pods treatment in comparison of SC_3 is 3.56 %.

Protein is sort of macronutrient that plays an important role in the formation of biomolecules. The protein structure composed C, H, O and N, as well as carbohydrates and fats, S and sometimes P, Fe and Cu. Generally, the oyster mushroom have a high enaught in protein, as well as amino acids in the oyster mushroom is also complete enaught. The higher protein and amino acid content is one of the superiority value compared to another oyster mushrooms. Furthermore Hassan, et al (2010), reported the research results on the crude protein content of mushroom fruiting bodies that treated in sawdust combinated with soy straw is 2.33 % and sawdust combinated with bagasse is 2.08 %.

The carbohydrate content of the oyster mushroom is high enough, but not include the starch, because the food reserves are stored as glycogen (Chang, 2007). The oyster mushroom nutrient content are varies, depending on the origin, cultivation areas including climate and environmental factors, and also the substrate type. The fiber content in all research treatments either in addition of cocoa pods waste on is higher than fiber content in control treatment.The increasing fiber content in brown oyster mushroom were suspected caused of the ability to absorb the compounds in the substrate.

3.4 The nutrients content of the growing media.

The research result showed that the treatment cocoa pods wastes have a significant effect N total, P_2O_5, K_2O, and C-organic content in oyster mushroom with a significance of all parameter values below 0.05 (sig. <0.05). Showed in Table 4 as follows.

Table 4. Data of N total, P_2O_5, K_2O and C-organic content in Brown Oyster Mushroom on Cocoa pods Wastes Treatment

Comparison of WasteTreatment (SC)	Observations type*)			
	N Total Content (%)	P_2O_5 Content (ppm)	K_2O Content (ppm)	C-Organic Content (%)
SC_0 (100% : 0%)	0,07 [a]	181,97 [a]	63,73 [a]	46,91 [a]
SC_1 (80% : 20%)	0,45 [a]	196,40 [a]	148,27 [b]	52,69 [b]
SC_2 (75% : 25%)	0,66 [a]	304,07 [b]	209,60 [c]	59,99 [d]
SC_3 (70% : 30%)	0,85 [b]	464,17 [c]	223,23 [c]	63,54 [e]

Description:
*) The numbers are accompanied by the same notation in the same column are not significantly different.

The effect of the addition of fruit poods waste cocoa on the substrate in baglog, in generally there is a tendency of increase in the total nitrogen content, P_2O_5, K_2O and C-organic. The highest N-total content in addition to the cocoa pods in comparison of SC_3 is 0.85 %. The highest P_2O_5 content is in cocoa pods treatment in comparison of SC_3 is 464.17 ppm. The highest K_2O content is in cocoa pods treatment in comparison of SC_3 is 223.23 ppm. The highest C-organic content in addition to the cocoa pods in comparison of SC_3 is 63.54 %. Substrates of material primarily consists of waste sawdust albazia has a high cellulose content and low lignin content so it is good to use as a medium to grow mushrooms. Sawdust from albazia has a low lignin content of about 25.7 % and had a high cellulose content (46.0 % alpha-cellulose and holo-cellulose 74.9 %).

4. Conclusions

Based on the data of all parameters in the research results, it can be concluded that the addition of the cocoa pods wastes as a of growing media supplement have a significant influence on the productivity and nutrient content in brown oyster mushroom, also nutrient growing media. The suggestion in using this growing media supplement with comparisons 75% sawdust and 25% cocoa pods waste (SC_2), it is recommended to be applied because the treatment would increase productivity and nutrient content brown oyster mushroom. The use of industrial wastes such as sawdust wood and cocoa pods wastes for brown oyster mushroom cultivation is one way of handling plantations waste.

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