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Effects Nutrient Additives of NPK Fertilizer and Coconut Water on the Yield of White Oyster Mushroom (*Pleurotus ostreatus*)

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ABSTRACT

White oyster mushroom (*Pleurotus ostreatus*) requires a source of nutrients for growth and development. The provision of NPK fertilizer aims to increase the source of media nutrients so that the results obtained are better in quantity and quality. Growth regulators can stimulate the relatively long growth of oyster mushroom mycelium. Growth regulators contain hormones that can support growth rates. One alternative natural growth regulator that can be used is coconut water. The research was carried out at the oyster mushroom kumbung at Pekanbaru, using a completely randomized design, consisting of 2 factors and three replications. The first factor was NPK fertilizer consisting of 4 levels (0, 7.5, 10, 12.5) g per *baglog*. The second factor was coconut water consisting of 4 levels (0, 3, 6, 9) ml per *baglog*. Data were analyzed using Analysis of Variance and further tested using DNMRT level 5%. The results showed that adding 10 g of NPK fertilizer and 6 ml of coconut water per *baglog* was a better dose for the number of fruit bodies, fresh fruit body weight, fruit cap diameter, fruit stalk length, and biological efficiency.

Keywords: Coconut water, NPK fertilizer, white oyster mushroom

INTRODUCTION

White oyster mushroom (*Pleurotus ostreatus*) is a food mushroom from the Basidiomycota group that likes by the community because of its delicious taste. The fruiting bodies of mushrooms are rich in vitamins, especially vitamin B1, vitamin B2, vitamin C, and vitamin D2 (Manzi *et al*. 2004). Oyster mushrooms also have several compounds such as lectins, polysaccharides, polysaccharide-peptides, polysaccharide-protein complexes. Every 100 g of fresh weight of white oyster mushrooms contains 27.25 g protein, 56.33 g carbohydrates, 2.75 g fat, 33.40 g fiber, 20 mg calcium, 9.1 mg iron, 18.10 g sugar, and ash 6.74 g (Stamets 2005). These compounds have benefits in the medical world, such as anti-oxidants, anti-cancer, anti-microbial, anti-diabetic, anti-hypercholesterolemic (Cohen *et al.* 2002).

Fungal growth and development require a source of nutrients such as Nitrogen, Phosphorus, Sulfur, Potassium, Carbon, and several other elements. Media nutrition plays a significant role in the oyster mushroom cultivation process. Oyster mushroom production can be optimal if factors that support growth are considered, such as substrate maturity, additional nutrients, and selection of substrate types. Mushroom cultivation will grow well on wood that has rotted or wood undergoing weathering. Mushroom cultivation requires sawdust as a growing medium. In addition to sawdust, other additional materials are needed, including rice bran, lime, and NPK fertilizer. NPK fertilizer is a compound fertilizer that contains more than one primary nutrient and includes secondary or tertiary nutrients (Lingga and Marsono 2008). The advantage of using compound fertilizers is that the nutrients they contain are complete, so there is no need to provide or mix various single fertilizers.

NPK fertilizer as an additional nutrient accelerates the growth of mycelium and increases the production of oyster mushrooms. Mahadi *et al* . (2016) stated that applying 10 g of NPK fertilizer per baglog could increase the number of white oyster mushroom caps by 10.33, the length of the oyster mushroom stalk to 4.73 cm, and the wet weight of white oyster mushroom 92.23 g. The response of growth and yield of oyster mushrooms due to NPK

fertilizer additives was also shown in Mulatsih and Asrafuddin (2020) that giving 10% NPK concentration gave the best mushroom weight 148.24 g.

The problem faced in cultivating oyster mushrooms is the growth of the mushroom mycelium, which is still relatively old. In general, the growth of fungal mycelium is between 45-60 days. Mycelium growth can be stimulated by growth regulators (PGR). Growth regulators contain hormones that can support growth rates. PGR can be obtained both naturally and synthetically. The use of natural PGR is more profitable than synthetic ZPT because the price is lower, easy to obtain, and the effect is not much different from synthetic PGR. One of the natural ZPT alternatives that can be used is coconut water. Coconut water contains sugar (1.7% - 2.6%) and micro minerals that serve as a source of nutrition for mushrooms. Coconut water contains organic acids and amino acids that are beneficial for plant growth (Yong *et al*. 2009). According to Yusnida (2006), coconut water contains the hormone auxin 0.07 mg l^{-1}, cytokinin 5.8 mg l^{-1}, and a small number of gibberellins and other compounds stimulating germination growth.

The use of coconut water as a nutritional additive is an appropriate alternative technology to increase the production of oyster mushrooms. Azizah *et al* . (2019), watering coconut water with a concentration of 50%, increased the number of mushroom fruiting bodies by 18.00 fruit, fresh fruit weight 90.37 g, and fresh weight for three harvests 309.75 g. Given 15% rice bran and 30% coconut water concentration produced a hood diameter of 8.43 cm, number of fruit bodies 17.92, and fresh weight of oyster mushrooms 340.83 g (Maula *et al*. 2018).

The provision of nutritional additives for NPK fertilizer and coconut water is one of the efforts to increase yields in oyster mushroom cultivation. Based on the background described, this shows that adding nutritional additives for NPK fertilizer and coconut water can be used as a mixture of growing media. This study aimed to determine the interaction of nutritional additives for NPK fertilizer and coconut water on the yield of white oyster mushroom (*Pleurotus ostreatus*) and a single factor.

MATERIALS AND METHODS

Study Sites

This research was conducted at the oyster mushroom kumbung, Jalan Swakarya Gang Berlian, Pekanbaru. This research was carried out for four months, starting from September 2019 – January 2020. The materials used in this study were sawdust, rice bran, dolomite, NPK fertilizer (16:16:16), young coconut water, F2 seeds of white oyster mushroom. Clear *polypropylene* (PP) plastic measuring 18 cm × 35 cm, newsprint, spirit, masking tape, rubber band, and 70% alcohol.

The tools used in this research are *baglog press* machine, *baglog steamer* (*steamer*), scales, scissors, spatula, syringe, cart, shovel, bunsen, paralon ring, *hand sprayer*, ruler, *hygrothermometer*, digital camera, *knapsack sprayer* 161, and tools write.

Research Design

This study was carried out according to a completely randomized design (CRD) consisting of 2 factors and three replications. The first factor was NPK fertilizer, and the second factor was coconut water, each factor consisting of 4 levels. The first factor was NPK fertilizer (P) consisting of P_0 = NPK 0 g per *baglog* , P_1 = NPK 7.5 g per *baglog* , P_2 = NPK 10 g per *baglog* and P_3 = NPK 12.5 g per *baglog* . The second factor is coconut water (K), consisting of K_0 = 0 ml of coconut water per *baglog*, K_1 = 3 ml of coconut water per *baglog*, K_2 = 6 ml of coconut water per *baglog,* and K_3 = 9 ml of coconut water per *baglog*. Thus there were 16 treatment combinations with three replications, so there were 48 experimental units. Each experimental unit consisted of 6 *baglogs,* and two *baglogs were* taken as samples so that the total population was 288 *baglogs* and 96 *baglogs* as samples. Data were analyzed using Analysis of variance followed by *Duncan's New Multiple Range Test* (DNMRT) at a 5% level.

Media Preparation

The research implementation included the preparation of the research site. The research place was a kumbung with two elongated 3-storey shelves that accommodate ±2,000 *baglogs*. Preparation of planting media included taking and selecting sawdust (mahang wood powder), mixing planting media with a composition of 100 kg sawdust, 10 kg rice bran, 3 kg dolomite, and application of NPK fertilizer according to treatment. NPK fertilizer was crushed to make it smoother and mixed evenly in the planting media. The mixed media was then put into a *polypropylene* (PP) plastic bag, weighed 1 kg, and compacted. The media was then sterilized at a 95 to 100 ° C temperature for ± 12 hours. The sterilized planting medium was then cooled until the

temperature dropped to 35 to 40 °C. Next, the seeds were inoculated in a room sterilized by spraying 70% alcohol. Mushroom seeds were inserted with corn media containing 10 grains of mycelium to the surface of the growing media. After inoculation of the seeds, coconut water was given. The coconut water given is young. According to the treatment, coconut water was applied by injection at the top, middle, and bottom of the *baglog*. Then the injection site was covered with tape. The planting medium was inoculated, stored at room temperature incubation, and maintained at 22 ºC – 28 ºC for 21 days - 30 days. *Baglog* was transferred to the fruiting body growth room, namely kumbung after the mycelium had filled the *baglog*.

Harvesting and Observation

Furthermore, the growth of the mushroom fruiting body is done by opening the *baglog* cover paper. The temperature and humidity of the room are kept stable by misting the water on the kumbung. Mushroom harvesting was carried out according to the criteria, namely the mushroom fruit bodies were not in full bloom, not faded, not old, the spores had not been released, and the texture was still firm, flexible, and not complicated.

Observations made were the speed of mycelium growth, *pinhead* emergence, harvest age, number of fruit bodies, fresh fruit body weight, fruit cap diameter, fruit stalk length, and biological efficiency.

RESULTS AND DISCUSSION

Interaction of Applying NPK Fertilizer and Coconut Water on White Oyster Mushroom Yield

The results of variance showed that the addition of NPK fertilizer additives and coconut water on the yield of white oyster mushrooms had no significant effect on all parameters (mycelium growth rate, *pinhead* emergence speed, harvest age, number of fruit bodies, fresh fruit body weight, fruit cap diameter, length of fruiting body), fruit stalk and biological efficiency). The average observations can be seen in Table 1.

The process of making *baglog* in this study *consisted of* wood powder (100%), rice bran (10% - 15%), and dolomite ($CaMg(CO_3)_2$) (3%). This composition is the elemental composition in oyster mushroom cultivation. The suitable composition will result in fulfilled nutrients for the growth of white oyster mushrooms. Mycelium will also be easy to grow with sufficient organic materials.

The use of sawdust as a base material for planting media will make mycelium grow optimally. According to Hariadi *et al* . (2013), treatment with sawdust composition >50% resulted in faster mycelium spreading time. High cellulose and lignin content with adequate nutrition is suitable for supporting mycelium growth.

Rice bran is the residue from the pounding or milling of rice grain. The rice bran contains several nutrients necessary for the growth and development of fungi. The nutritional content of rice bran includes water content of 2.49%, protein 8.77%, fat 1.09%, ash 1.60%, fiber 1.69%, carbohydrates 84.36%, and calories 382.32 kcal (Research Center and Bogor Agricultural Development in Rochman 2015). The use of sawdust and rice bran substrates produced the highest average mycelium growth of 1.29 mm day^{-1} on *P. salmoneostramineus* (pink oyster mushroom) and 1.17 mm day^{-1} on *P. ostreatus gray* (*grey* oyster mushroom) (Owaid *et al* . 2015). Hassan *et al* . (2010) found mycelium growth reached 8.9 mm day^{-1} on *P. eryngii* (oyster mushroom) with a rice bran substrate and sawdust soybean and rice straw.

The white oyster mushroom growing media used must support optimal fungal growth. The pH of the medium must be suitable for the growing conditions of the fungus, which can be adjusted by adding dolomite ($CaMg(CO_3)_2$). Carbonate lime (dolomite) is also used as a source of calcium (to strengthen the media so that it is not easily damaged, has long durability, and has a long production period) and to increase the minerals needed for growth (Istiqomah and Fatimah 2014).

Table 1 shows that without applying NPK fertilizer and coconut water, the mycelium growth was fast to fill the entire surface of the baglog, which was 25 days. However, the thickness of the mycelium produced was very different if NPK fertilizer and coconut water were given. Based on field observations, the media given NPK fertilizer and coconut water produced thicker mycelium than without NPK fertilizer and coconut water. As a result, the application of NPK fertilizer and coconut water caused the mycelium to need a longer time to fill the entire surface of the *baglog* but accelerated the growth of *pinheads by* 48.67 days. Application of NPK fertilizer in the media can accelerate the growth of *pinhead* for 54.4 days and produce a total wet weight of 181 g of mushrooms (Herlina *et al.* 2012). These results are due to N's availability in the media fungi need during vegetative growth,

Table 1. Interaction of nutrient additives of NPK fertilizer and coconut water on white oyster mushroom yield.

NPK Fertilizer (g baglog^{-1})	Coconut water (ml baglog^{-1})	Mycelium Growth Speed (days)	Pinhead Emergence Rate (days)	Harvest Age (days)	Number of Fruiting Bodies (fruits per baglog)	Fresh Fruit Body Weight (g)	Fruit Cap Diameter (cm)	Fruit stalk length (cm)	Biological Efficiency (%)
0	0	25.00	52.17	54.33	5.86	50.72	9.05	3.49	30.43
	3	25.00	53.33	55.50	5.22	50.50	9.03	3.33	30.30
	6	25.00	53.50	55.50	6.14	50.92	8.60	3.64	30.55
	9	25.00	51.67	53.83	5.97	50.50	9.10	3.48	30.30
7.5	0	28.83	54.17	58.33	6.14	50.11	9.63	3.27	30.07
	3	31.83	50.17	52.33	6.75	51.70	9.40	3.00	31.02
	6	29.17	48.67	51.33	6.55	51.33	9.50	3.29	30.80
	9	31.00	48.83	49.67	7.41	50.40	8.91	3.20	30.23
10	0	28.83	51.00	53.17	5.72	50.67	9.27	3.23	30.40
	3	29.00	56.50	59.50	5.67	50.77	8.50	2.93	30.47
	6	30.00	55.33	58.00	5.81	54.22	9.21	3.19	32.53
	9	30.67	54.17	57.50	6.11	50.97	9.11	2.98	30.58
12.5	0	30.83	53.33	55.83	6.17	50.33	8.65	3.13	30.20
	3	30.67	53.67	55.83	6.14	50.50	8.91	3.09	30.30
	6	30.67	57.00	58.67	5.55	50.64	8.54	2.79	30.38
	9	30.83	57.33	60.00	5.94	50.05	8.61	2.94	30.03

Note: Numbers in the same column and not followed by lowercase letters are not significantly different according to the DNMRT' test at the 5% level

especially mycelium growth. A protein is one of the essential nutrients needed for mycelium growth besides lignin, cellulose, and hemicellulose (Seswati *et al.* 2013). Elemental N is used for protein synthesis. If the element of N is available in sufficient quantities, protein synthesis will run smoothly so that the mycelium can grow properly. The study of Maula *et al* . (2018) showed that the treatment dose of rice bran and coconut water concentration had a significant effect on the depth of the mycelium. The higher the dose of rice bran and the concentration of coconut water, the deeper white oyster mushroom mycelium penetrates the growing media and the thicker the mycelium.

Effects Nutrient Additives of NPK Fertilizer on White Oyster Mushroom Yield

The application of NPK fertilizer additives on the yield of white oyster mushrooms had a significant effect on the parameters of mycelium growth speed, *pinhead* emergence speed, harvest age, number of fruit bodies, and fruit stalk length but had no significant effect on fresh fruit body weight, fruit

Table 2. Effects Nutritional additives of NPK fertilizer on the yield of white oyster mushrooms.

Parameter	NPK Fertilizer (g baglog^{-1})			
	0	7.5	10	12.5
Mycelium Growth Speed (days)	25.00 b	30.21 a	29.63 a	30.75 a
Pinhead Emergence Rate (days)	52.67 ab	50.46 b	54.25 a	55.33 a
Harvest Age (days)	54.79 ab	52.92 b	57.04 a	57.58 a
Number of Fruiting Bodies (fruits per *baglog*)	5.80 b	6.71 a	5.83 b	5.95 b
Fresh Fruit Body Weight (g)	50.66	50.88	51.67	50.38
Fruit Cap Diameter (cm)	8.95	9.36	9.02	8.67
Fruit stalk length (cm)	3.48 a	3.19 b	3.08 b	2.99 b
Biological Efficiency (%)	30.39	30.53	30.99	30.23

Note: Numbers in the same row followed by different lowercase letters show significantly different according to the DNMRT' test at the 5% level.

cap diameter, and biological efficiency. Further test results are presented in Table 2.

The application of NPK fertilizer of 7.5 g, 10 g, and 12.5 g was not significantly different in the parameters of mycelium growth speed and fruit stalk length but significantly different compared to without NPK fertilizer additive nutrition. The application of 7.5 g NPK fertilizer additives was significantly different from the 10 g and 12.5 g NPK fertilizer additives but not significantly different from that without NPK fertilizer additive nutrition on *pinhead* speed and harvest age parameters. Without nutrients, NPK fertilizer additives were not significantly different from the 10 g and 12.5 g NPK fertilizer additives on *pinhead* emergence speed and harvest age parameters. The number of fruit bodies with the addition of 7.5 g NPK fertilizer additive nutrition was significantly different from the 10 g, 12.5 g NPK fertilizer additive nutrition and without NPK fertilizer additive nutrition.

The application of fertilizer follows the needs of the fungus. Growth will be maximized if the required nutrients are available and can meet the needs of plants. In Table 2, it can be seen that the vegetative parameters, namely the speed of mycelium growth, the speed of *pinhead* emergence, and the harvest time of the 7.5 g NPK fertilizer treatment, showed promising results. These three parameters are closely related because the faster the mycelium growth rate and the emergence of *pinheads*, the faster the harvest time and vice versa. However, when the mycelium grows faster, the *pinheads* appear later so that the harvest time is also slow because the mycelium is not too thick. NPK compound fertilizers can be added to the growing media to increase the availability of Nitrogen, Phosphorus, and Potassium elements. According to Suparti and Marfuah (2015), the addition of Nitrogen can accelerate the mycelium and help the hood's formation. Phosphorus serves to form vegetative parts such as hoods and stalks. Potassium also forms fruiting bodies as an enzyme activator and primordia development.

Table 2 shows a tendency to decrease fertilizer use efficiency when the fertilizer dose increases. Kalsum *et al*. (2011) stated that proper fertilizer application is a factor that cannot be ignored. The addition of fertilizers is done to increase the nutrients needed by fungi so that their growth and development are better and the resulting product will be higher.

The saturation of inorganic materials will result in the nutrients given to the fungus not giving a good response. If the nutrient content in the mushroom plant media is met, the mushrooms will not absorb the added nutrients. According to Afief *et al*. (2015), increasing the dose of NPK compound fertilizer up to 10.21 gram per baglog increased the mushroom stalk up to 4.5 cm, and the stalk length decreased when the dose increased. Excessive fertilizer application can reduce the production of oyster mushrooms because compound fertilizers such as NPK give an acid-reacting residue. Hasibuan (2006) stated that almost all compound fertilizers create residues that react with acid, except when specific treatments are given because the N carrier is ammonia, so the pH of the sawdust media will decrease and become more acidic.

Effects Nutrient Additives of Coconut Water on White Oyster Mushroom Yield

The results of variance showed that coconut water additive nutrition on white oyster mushroom yields had no significant effect on the parameters of mycelium growth speed, pinhead emergence speed, harvest age, number of fruit bodies, fresh fruit body weight, fruit cap diameter, fruit stalk length,

Table 3. Effects coconut water additive nutrition on white oyster mushroom yield

Parameter	Coconut Water (ml)			
	0	3	6	9
Mycelium Growth Speed (days)	28.38	29.13	28.71	29.38
Pinhead Emergence Rate (days)	52.67	53.42	53.63	53.00
Harvest Age (days)	55.42	55.79	55.88	55.25
Number of Fruiting Bodies (fruit per *baglog*)	5.97	5.95	6.01	6.36
Fresh Fruit Body Weight (g)	50.46	50.87	51.78	50.48
Fruit Cap Diameter (cm)	9.15	8.96	8.97	8.93
Fruit stalk length (cm)	3.28	3.09	3.23	3.15
Biological Efficiency (%)	30.27	30.52	31.06	30.28

Notes: Numbers in the same row and not followed by lowercase letters are not significantly different according to the DNMRT' test at the 5% level.

and biological efficiency. The average observations can be seen in Table 3.

Table 3 shows that the nutritional supplementation of coconut water on the yield of white oyster mushrooms tends to be the same in all parameters. Likely, the fungus has not optimally utilized the coconut water given to the growing media. Giving coconut water on the base media tends to evaporate from the media (evaporation). Another possibility is that the nutrients in the media have been fulfilled so that the mycelium will also be easy to grow with sufficient organic materials. Similar results by Yuniarti (2004) that coconut water and dekamon (a growth regulator) given to mushrooms did not respond well.

Giving coconut water has not shown optimal results on oyster mushrooms. The results show that coconut water is not limited to mushroom cultivation. Growing media produced relatively the same number of fruiting bodies.

CONCLUSIONS

The interaction nutritional additives of NPK fertilizer and coconut water had no significant effect on all parameters. Nutrition for NPK fertilizer additives significantly affected mycelium growth speed, pinhead emergence speed, harvest age, number of fruit bodies, fruit stalk length, while coconut water additive nutrition had no significant effect on all parameters.

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