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UTILIZATION OF AGRICULTURAL WASTE FOR CULTIVATION OF PADDY STRAW MUSHROOM (VOLVARIELLA VOLVACEA)

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ABSTRACT

Volvariella volvacea (Bull.) Singer 1951 or Paddy straw mushroom is one of the edible mushrooms that cultivated in the tropical and subtropical area. The mushroom usually is grown on the lignocellulosic agricultural waste as a substrate. The utilization of three kinds of agricultural waste as growth media: paddy straws, cotton wastes and banana leaves were used. The composted process was done in 7 days with the addition of 2% (w/w) of CaCO3, 20% (w/w) of rice bran and 0.5% (w/w) of urea fertilizer. The media were laid on the shelf in the 3.0 x 4.0 x 3.0 meter of mushroom house and pasteurized at 60--70°C for 4--6 hours. The spawn was inoculated when the temperature was cooled down to be 35oC. The results showed mycelia have fully grown to cover the surface of media at 5 days (cotton wastes and paddy straws) and 6 days (banana leaves) after inoculation. The first fruiting body appeared at the egg stage of 7 days (paddy straws and cotton wastes) and 8 days (banana leaves). Proximate composition analysis showed that protein content was 37.38%, 27.95%, and 20.84% of paddy straws, cotton wastes and banana leaves respectively. Meanwhile, the carbohydrate content of 5.11%, 4.26% and 3.74% was obtained of banana leaves, cotton Wastes, and paddy straws. The highest biological efficiency was shown from production using cotton Wastes of 17.69%; banana leaves of 8.56%; and paddy straw of 7.93%. Statistical analysis showed no significant different on cultivation using cotton wastes, paddy straws and banana leaves.

KEYWORDS: *Agricultural waste, cultivation, growth media, production, Volvariella volvacea.*

INTRODUCTION

V.volvacea (Bull.) Singer 1951 also called paddy straw or Chinese mushroom, an edible basidiomycete, occurs in both tropical and subtropical region of the world (Ukoima et al., 2009) It is one of the most highly priced and preferred edible mushroom because of its taste, desirable flavor and medicinal value (Apetorgbor et al., 2015). The nutritional value of this mushroom can be equated with eggs, milk and meat (Oey, 2005). Mushrooms are highly nutritious with high quality protein value, minerals (Fosfour, Kalium, Ferum) folic acid, low in starch, fat and sodium (Ahlawat and Tewari, 2007; Apetorgbor et al., 2015). They contain certain compounds which are anticancerous, anti-viral, anti-hyper and hypertensive. They display ability to lower cholesterol levels in the body (Belewu and Belewu, 2005; Ukoima et al., 2009; Apetorgbor et al., 2015). V. volvacea is considered to be one of the easiest mushrooms to cultivate due to its short incubation period of 14 days. This mushroom usually

grown on the lignocellulosic agricultural waste, one of them is paddy straw, as natural growth media. But, they cannot used lignocellulosic media without composted process. Composting is a process that allows the microbial decomposers to reduce the tensile strength of the rice straw. This also prepares the straw for easy colonization by the mycelium of the paddy straw mushroom (Reyes, 2000). Indicators for good composting can be seen from soft texture of the compost and brown-black of the colour of the compost with pH 6—8. V.volvacea is considered to be the easiest mushroom to cultivate, but production of this mushroom in Indonesia is not optimum yet. Production of edible mushroom in Indonesia in 2014 decreased from 44.565 ton to 37.410 ton. It is important to look for various high lignocellulose content of agricultural waste use as growth media of paddy straw mushroom. Some agricultural wastes have lignosellulosic component, such as paddy straw, cotton wastes and banana leaves. Dry substrate of paddy straws contain 27% of hemicellulose, 39% of cellulose, and 12% of lignin. Cotton wastes contain 50% of cellulose with low lignin contain, 8—10%. Banana leaves contain 24.19% cellulose, 24.04 % hemicellulose (Belewu and Belewu, 2005) and 13.3% lignin (Oliveira et al., 2009). In this study, we proposed to utilize variaous of lignocellulosic waste as growth media to increase production of V.volvacea. nutritious with high quality protein value, minerals (Fosfour, Kalium, Ferum) folic acid, low in starch, fat and sodium (Ahlawat and Tewari, 2007; Apetorgbor et al., 2015). They contain certain compounds which are anticancer, anti-viral, anti-hyper and hypotensive. They display ability to lower cholesterol levels in the body (Belewu and Belewu, 2005; Ukoima et al., 2009; Apetorgbor et al., 2015). V. volvacea is considered to be one of the easiest mushrooms to cultivate due to its short incubation period of 14 days. This mushroom usually grown on the lignocellulosic agricultural waste, one of them is paddy straw, as natural growth media. But, they cannot used lignocellulosic media without composted process. Composting is a process that allows the microbial decomposers to reduce the tensile strength of the rice straw. This also prepares the straw for easy colonization by the mycelium of the paddy straw mushroom (Reyes, 2000). Indicators for good composting can be seen from soft texture of the compost and brown-black of the colour of the compost with pH 6—8. V.volvacea is considered to be the easiest mushroom to cultivate, but production of this mushroom in India is not optimum yet. It is important to look for various high lignocellulose content of agricultural waste use as growth media of paddy straw mushroom. Some agricultural wastes have lignosellulosic component, such as paddy straw, cotton wastes and banana leaves. Dry substrate of paddy straws contains 27% of hemicellulose, 39% of cellulose, and 12% of lignin. Cotton wastes contain 50% of cellulose with low lignin contain, 8—10%. Banana leaves contain 24.19% cellulose, 24.04 % hemicellulose (Belewu and Belewu, 2005) and 13.3% lignin (Oliveira et al., 2009). In this study, we proposed to utilize variaous of lignocellulosic waste as growth media to increase production of V. volvacea.

MATERIALS AND METHODS:

Preparation of media:

Paddy straws, cotton wastes, and banana leaves are used as growth media for V.volvacea. Cotton wastes were obtained from textile industry. While paddy straw and banana leaves were obtain from rural areas farmers. Samples were soaked overnight in water. Soaking is an important process since it softens the strands of straw which facilitates the composting process (Reyes, 2000).

Composting

The composting process was done on 7 days. The raw materials were added with 2% (w/w) of lime, then covered with plastic sheet to induce the growth and proliferation of thermophilic decomposer. The composted is shredded to release residual gas such as ammonia which is toxic to the growth of mushroom. On the 5th day, the compost was added with 20% (w/w) of rice bran and 0.5% (w/w) of urea fertilizer, and to continue process for two more days.

Steaming, Spawning and Incubation

The media were lay on the shelf in the 3,0 x 4,0 x 3,0 meter of mushroom house and pasteurized at 60--70°C for 4-6 hours. It was need an overnight to cool down the room temperature in the mushroom house. The spawn then was inoculated into substrate when the temperature in mushroom house is about 35oC. Spawn was obtained from Chandra Shekhar Azad Agricultural University Kanpur U.P. The mycelium was fully growth on 5 days at 30--35oC with relative humidity 80-90%. After 5 days, the temperature and humidity of mushroom house was kept by sprinkling water and open the window.

Fruiting and Harvesting

There are three stage of the fruiting body of paddy straw mushroom. They are button stage, egg stage and elongation or mature stage (Chang and Quimio, 1989). Mushrooms are harvesting at the button or egg stage. Harvesting was done by holding the button and twisting followed by an upward pull (Reyes, 2000). Several parameter of fruit body such as diameter, the number and weight of fruiting body were determined (Bonatti et al., 2004; Apetorgbor et al., 2015). The data were collected during production of paddy straw, including diameter of fruiting body (cm), the number of fruiting body, and fresh weight (g). The biological efficiency of paddy straw mushroom on different media was calculated with formula (Apetorgbor et al., 2015).

$$\text{Biological efficiency} = 100 \times \frac{\text{Total fresh weight fruiting body}}{\text{Total weight of growing media}}$$

The data were statistically computed analysis of variance (ANOVA) with error rate at P = 5% to know significant different between diameter hood, the number of fruiting body, wet weight, biological efficiency and proximate analysis of paddy straw mushroom on three different growth media.

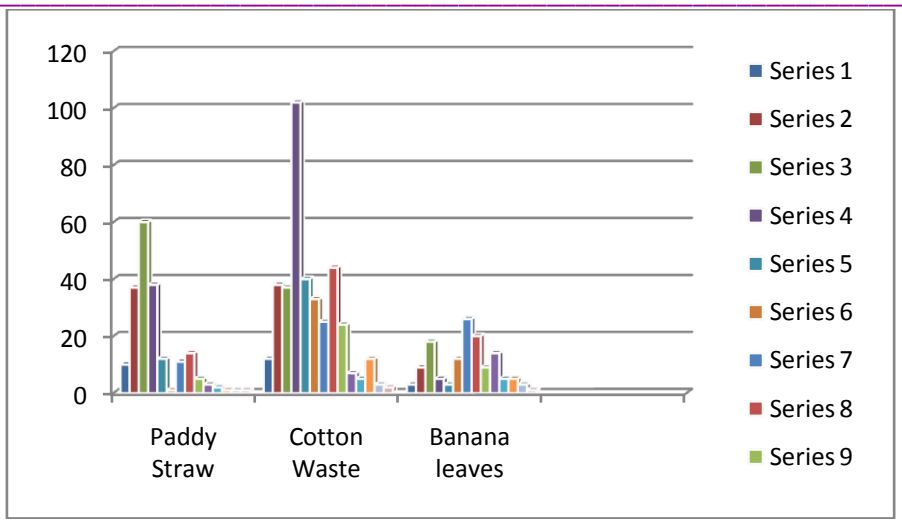
RESULTS:

Growth of mycelium and fruiting body formation

There are two stages of cultivation in paddy straw mushroom, mycelium growth and fruiting body formation stages (Samarawira, 1979). The result of cultivation using 3 different growth media show mycelium full the surface of growth media 5 days after inoculation for paddy straw and cotton wastes media, followed by banana leaves on the next day. Mycelium then developed into fruiting body (primordial) on 6-7 days inoculation. The first harvesting on stage button/egg happened 7 days after inoculation for cotton waste and paddy straw, and 8 days after inoculation for banana leaves. The harvesting ended 25 days after inoculation with 14 times harvesting for each substrates .

The number of fruiting body

The number of fruit body production on 14 days harvesting time was demonstrated (Fig. 1). The results showed that utilization of paddy straw and banana leaves gave the highest number of fruiting body on the 3rd day of harvesting time and 4th day of harvesting time of cotton waste. It was 60, 102, and 26 on the peak of the number of fruit body of paddy straws, cotton wastes and banana leaves respectively. Statistical analysis result is as fallows.



Paddy straw 10.0 37.0 60.0 38.0 12.0 1.00 11.0 14.0 5.00 3.00 2.00 1.00 1.00 1.00
Cotton waste 12.0 38.0 37.0 102. 40.0 33.0 25.0 44.0 24.0 7.00 5.00 12.0 3.00 2.00
Banana leaves 3.00 9.00 18.0 5.00 3.00 12.0 26.0 20.0 9.00 14.0 5.00 5.00 3.00 1.00

Figure 1. The number of fruiting body on paddy straw, cotton waste and banana leaves substrates in 14 days of harvesting

The diameter of fruit body

Diameter of fruiting body expressed the quality of cultivated paddy straw mushroom as seen in Figure 2. The average of longest diameter of fruit body was obtained from cotton wastes substrates, followed by banana leaves and paddy straws of 2.71 cm, 2.58 cm and of 2.36 cm respectively. Statistical analysis are as fallows.

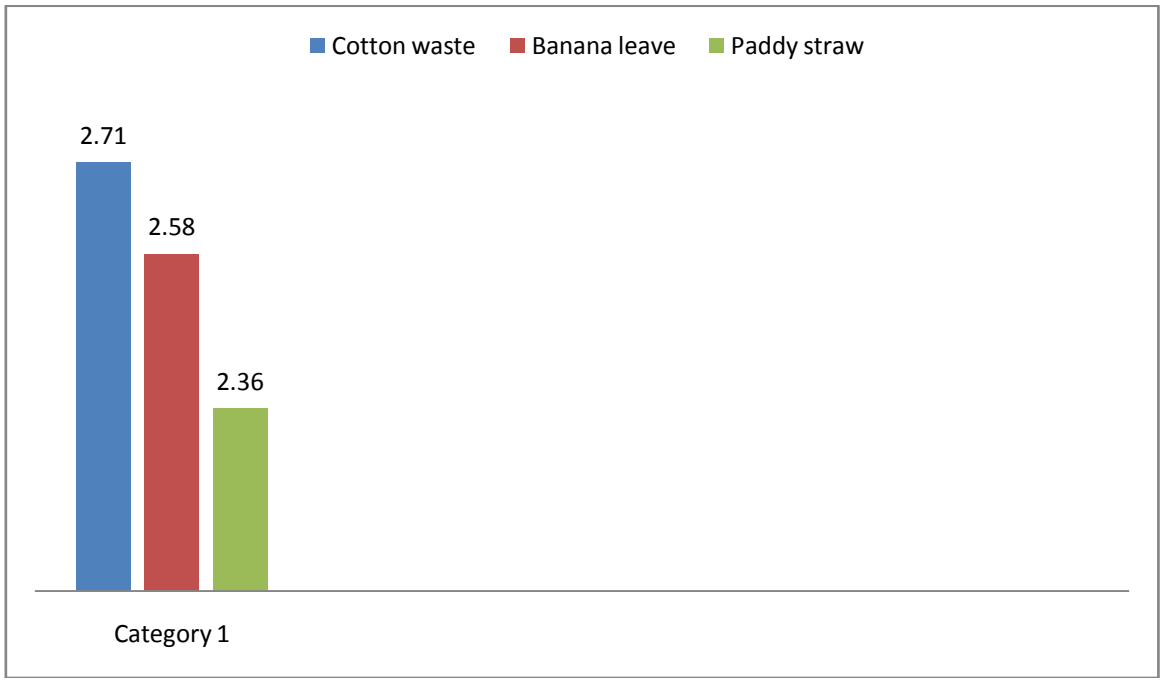


Figure 2. Diameter of fruiting body on paddy straws, cotton wastes and banana leaves substrates

The weight of fruit body on various substrates was resulted . The heaviest of fruiting body was obtained on substrate of cotton wastes of 995 gram on 4th day of harvesting, followed of 589 gram on 3rd day of paddy straw and 325 gram on 7th day of banana leaves. Furthermore, the heaviest of total weight of production fruiting body was on cotton wastes, followed by banana leaves and paddy straws of 3184.5 gram, 1540.5 gram and 1427.2 gram respectively.

Biological efficiency (BE)

Biological efficiency of paddy straw mushroom cultivated on various substrates was shown in Fig. 3. The results showed that the highest BE are obtained on cotton wastes, followed by banana leaves, and paddy straws of 17.69%, 8.65% and 7.93% respectively.

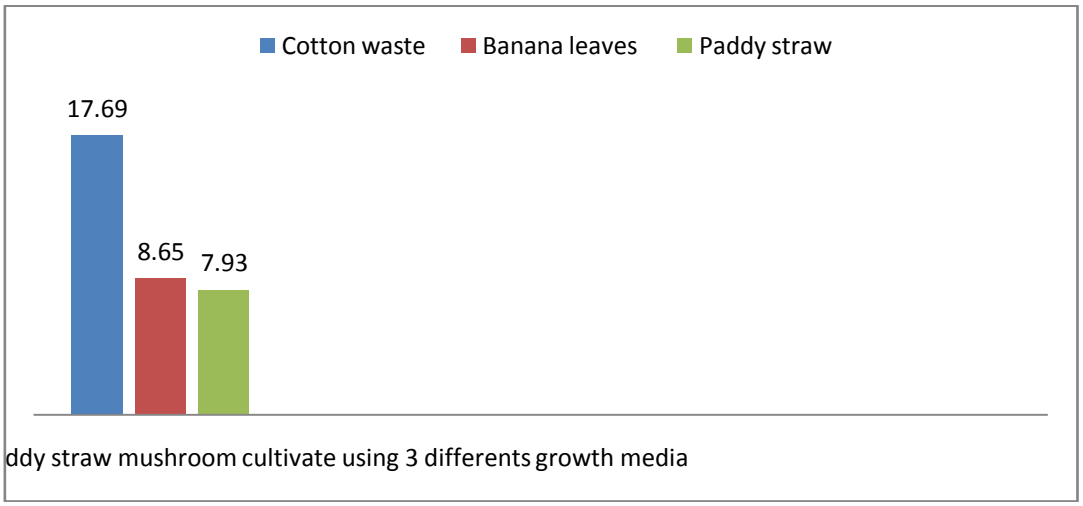


Figure3. Biological efficiency of paddy straw mushroom cultivate using 3 different growth media

Proximate analysis of paddy straw mushroom

Proximate analysis of fruiting body showed that fruit body produced by paddy straw as a substrate has the lowest content of total carbohydrate of 3.74%. However it contained the highest protein of 4.69%. Fruit body produced by banana leaves as a substrate has highest total carbohydrate of 5.11%.

Table 1. Nutrients content of paddy straw mushroom cultivated using 3 different substrate

Nutrient content	Paddy straw	Cotton waste	Banana leaves
Total carbohydrate (%)	3,74 ± 0,37	4,26 ± 0,84	5,11 ± 0,21
Total energy (kkal/g)	33,72 ± 5,60	31,68 ± 3,34	31,94 ± 1,66
Energyfrom fat (kkal/g)	0 ± 0,00	0,6 ± 1,04	1,04 ± 1,46
Water content (%)	90,49 ± 1,43	91,25 ± 0,85	91,40 ± 0,17
Total fat (%)	0 ± 0,00	0,07 ± 0,12	0,12 ± 0,16
Ashes (%)	1,08 ± 0,03	0,92 ± 0,07	0,76 ± 0,04
Protein (%)	4,69 ± 1,03	3,51 ± 0,40	2,62 ± 0,16

DISCUSSION

Mycelia growth is important phase in mushroom cultivation. Using banana leaves as substrate, it needed 6 days for fully growing mycelia, while the substrate of paddy straws and cotton wastes need 5 days. This result is almost similar with the work of Quimio et al., 1990 and Okhuoya et al., 2005. They reported that Carbon and Nitrogen content in substrates play an important role in growing of mycelia of V.volvacea. Furthermore, pH and temperature is also promote in growing of mycelia (Akinyele and Adetuyi, 2005) The curve pattern of fruiting body production and its characteristic were similar in three different lignocelullosic agricultural waste. There was only different in period of a peak in producing and charatecter of fruit body. Increasing of the number of fruiting body happened because growth media contain essential macro elements for crop production (potassium, calcium, phosphorous, magnesium, nitrogen and sodium). Generally, these essential nutrients combined in various media to stimulate fruit body formation and development of V. volvacea (Stamets, 2001). The composting process also plays important role on decomposed polymers in growth media, such as hemicelluloses and cellulose into their monomers, such as xylulose and glucose. Monomers are used as a nutrients for metabolisms and fruiting body formation on paddy straw mushroom (Chang and Miles, 2004). Cultivation of paddy straw mushroom using cotton wastes as a substrate showed best result on the number of fruiting body, diameter of fruiting body, wet weight of fruiting body and efficiency biology because the nutrients in substrates are optimum for fruiting body formation and create paddy straw mushroom with highest number of fruit body, wet weight, biology efficiency, and diameter of fruiting body. Dry substrate of paddy straws contained 27% of hemicelluloses, 39% of cellulose, and 12% of lignin cotton wastes contains 50% of cellulose with low lignin contain, 8-10%, when Banana leaves only contain 24,19% cellulose, 24,04% hemicelluloses (Belewu and Belewu, 2005) and 13,3% lignin (Oliveira et al., 2009). Paddy straw is a natural substrate for paddy straw mushroom (Fasidi, 1996) containing lignocelluloses contents. The temperature and relative humidity also play important role for fruiting body formation. The relative humidity on cultivation paddy straw mushroom shows 85-99% with average 91.9%. During cultivation, the minimum temperature for paddy straw mushroom growing was 27.8 ºC and maximum temperature was 35.9 ºC. The average daily temperature during cultivation was 31.7 ºC, This temperature is enough for growing paddy straw mushroom. The highest biology efficiency of cotton waste was 17.69%, followed by banana leaves, 8.56% and paddy straw 7.93%. This result was lower Quimio et al., (1990), they found that the biology efficiency of pure cotton waste ranged from 25 to 50% while that of rice and banana leaves ranged from 10 to 15%. This is happened because Coprinus sp. an organism competitor during cultivation. Growing of Coprinus sp. on growth media is faster when the temperature of cultivation dropped below 30 ºC, so the nutrients inside them was used for Coprinus sp.

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