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An Improved Compost Using Cotton Waste and Fermented Sawdust Substrate for Cultivation of Oyster Mushroom

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A composting technique was assessed to enhance efficiency in oyster mushroom substrate. Poplar sawdusts and by-product of winter mushroom added by 10% of rice bran were composted outdoors at 20°C to 28°C for 12 days. The duration of fermentation was shortened 3 days in fermented sawdust plot. The yield obtained from waste cotton substrate with fermented poplar sawdust was 742 g, whereas the yield from control 663 g. In addition, the substrate with by-product of winter mushroom was the most effective to composting. It was useful to apply the fermented sawdust and by-product to waste cotton for compost and sporophore production of oyster mushroom.

KEYWORDS: By-product, Compost, Ferment, Oyster mushroom, Poplar sawdust, Primordia, Recycle, Winter mushroom

Oyster mushroom has traditionally been one of the most popular edible mushrooms owing to its taste and flavor in eastern countries. A method of cultivation on the log of poplar was developed in 1960s, and another way was improved using the rice straw in 1970s. Since 1980s, waste cotton substrate was applied to the cultivation of oyster mushroom. From that time on, over 90% of oyster mushroom growers has applied waste cotton substrate to the cultivation. Composting technique derived from button mushroom cultivation has been introduced to oyster mushroom cultivation. The compost involves the substrate materials as well as the microorganisms which cause the breakdown and decay of the substrate materials in the process of composting, and these microorganisms teemed with millions of bacteria and fungi in the pile of compost are essential for composting. In *Agaricus* mushroom, composting system is composed of phase I and II. Phase I is to mix and wet the raw materials and to begin the composting process during which numbers of microorganisms break down the straw, and phase II is to destroy spores of contaminating microorganism and insect and pests in addition to keeping a uniform temperature of approximately 50 to 55°C (Chang and Miles, 1989). The main objectives in composting are to provide nutritions to grow the mushroom, and in consequence of composting, mushroom dominates at the expense of other competing microorganisms (Chang and Hayes, 1978). Cellulose is constructed with a long chain which form the fibers or structural strands of straw and hay, which need to be broken down by microorganism in the phase II to make fat (Carapiet, 1981). Commercial compost consists of horse manure compost to which 100 kg of chicken manure and 25 kg of gypsum have been added per ton (Gerrits, 1981). The procedure of phase II composting involves two successive stages such as pasteurizing and conditioning; For pasteurizing, the temperature of the compost is raised up to 60~62°C by introducing live steam or by heating furnaces occasionally accompanied by fresh air, and for conditioning, the temperature of the second stage is regulated to 48~52°C by the admission of a controlled amount of fresh air for 4~5 days (Wang and Shou, 1981). A method of sawdust spawn making was improved by fermented sawdust which was efficient to inhibit mycelial growth of *Trichoderma* sp. (Oh *et al*., 2003). Composting is essential to cultivating mushroom as the substrate should be decomposed into cellulose, hemicellulose and lignin by a large number of microorganisms to serve as an excellent source of food for mushroom mycelia. The composted substrate also plays an major role in inhibiting infection by harmful microorganisms while mushroom mycelia are predominating over the substrate. The purpose of this work is to determine possibility of rapid fermentation, yield increase and recycle of by-product by adding the supplements to waste cotton substrate. The results obtained from fermented sawdust are reported to improve method of fermentation of waste cotton.

Materials and Methods

Outdoor fermenting. Bottom of the substrate pile was built with grated floor to prevent activity of anaerobic microorganism in it. The poplar sawdust and by-product adjusted to 70% of water content was mixed with 10% rice bran, and piled up outdoors at 20°C during the night to 28°C during the day for 12 days (Fig. 1). A temperature of the pile was raised to 65°C in two days, and the

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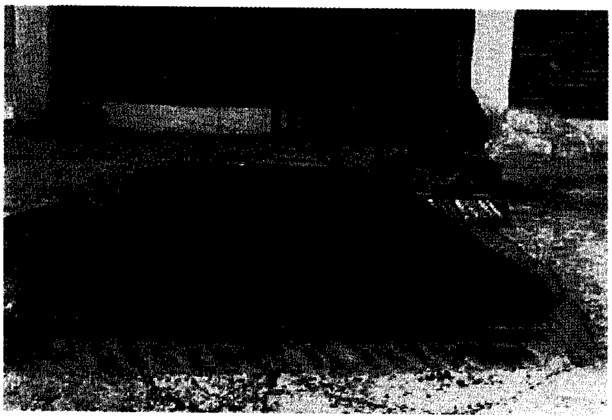

Fig. 1. Outdoor composting of poplar sawdust.

piled substrate was turned up outdoor every 4 days during 12 days to supply fresh air. There was no additional watering on the pile except for initial watering. When it's rainy the stack was covered with polythene sheet to prohibit the temperature down and excessive water content on the stack. On the other hand, additional water was applied to the poplar sawdust stack in turning-up to fix 70% water content.

Fermenting the substrate for oyster mushroom. Bales of raw material imported from Pakistan was untied by cutting machine. The lump of waste cotton was homogenized by the appliance manufactured by Daekang Co. in Korea, and water was simultaneously supplied. Water content of the waste cotton was fixed in approximately 70%. For the effect of yields followed by fermentation, the substrates were treated as 4 plots which were composed of waste cotton only, waste cotton with non-fermented poplar sawdust, waste cotton with fermented by-product of winter mushroom and waste cotton with fermented poplar sawdust. The substrate was mixed with 84% of waste cotton and 16% of supplements which were fermented, non-fermented sawdust and by-product. the substrate filled in the plastic box (40 cm × 40 cm × 12 cm) was put into a room in which a temperature was adjusted to 62°C for 12 h and maintained at 52~55°C for 5 days in order to pasteurize and condition. The fermenting room constructed by brick was 5 m × 10 m × 3 m in size. Live steam was introduced up and down by furnace (500 kg/h Newstar Co. in Korea). Fresh air was occasionally introduced through ventilating hole.

Results and Discussion

Condition of the substrate. Of three supplements, the by-product of winter mushroom showed was the best condition in fermentation. Waste cotton and waste cotton with non-fermented poplar sawdust were slowly progressed in fermenting. There was a little difference in the substrates

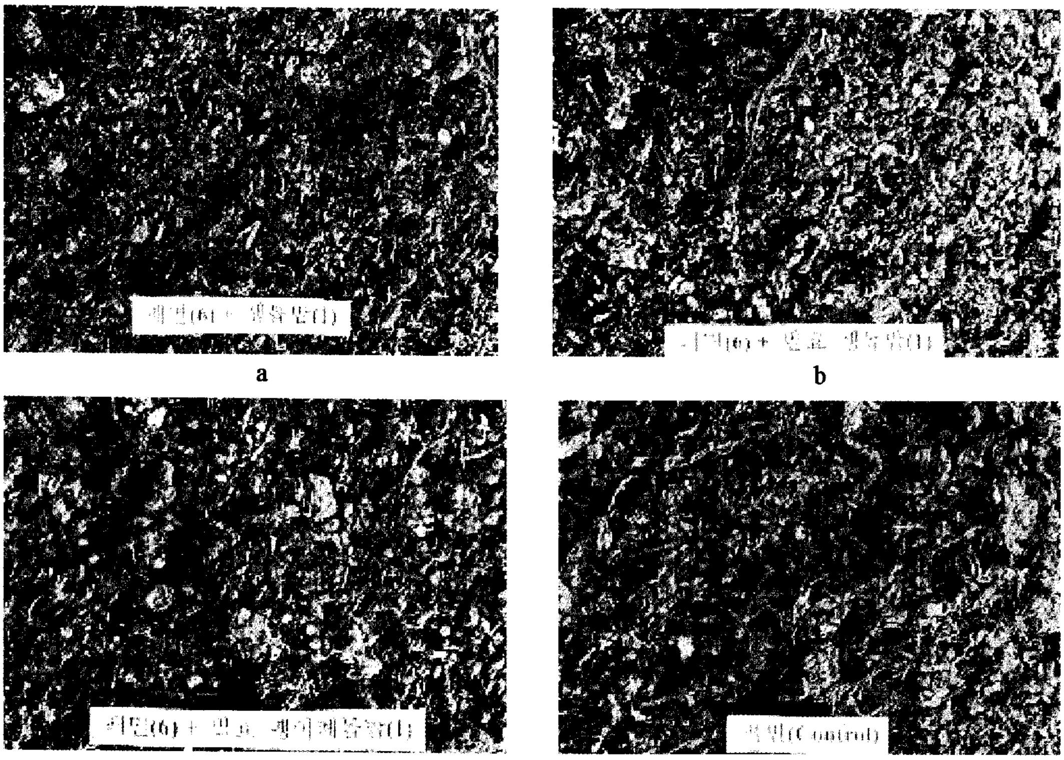

Fig. 2. Comparison of fermented substrates mixed with supplements (a: waste cotton with non-fermented poplar sawdust, b: waste cotton with fermented poplar sawdust, c: waste cotton with by-product of winter mushroom, d: control).

between the fermented poplar sawdust and the fermented by-product of winter mushroom (Fig. 2). So far little supplement were added to oyster mushroom substrate. On the other hand, in preparation of *Agaricus* mushroom compost chicken or poultry manure were usually supplemented to wheat straw so that the substrate might contain more nitrogen source. Optimum C : N ratio for *Agaricus* mushroom is about 17 of which the value produced most effective weight of fruit bodies (Smith and Hayes, 1972). Chang and Hayes (1987) described cellulosic plant materials contain different amounts of nitrogen: rice straw 0.58%, wheat straw 0.62%, barley 1.18%, cotton waste 0.65 to 1%, and banana leaves 1.71%. Woody tissue contain 0.03 to 1.0% nitrogen as compared to 0.58 to 1.71% in herbaceous residues. The carbon:nitrogen ratio in most woody tissue is in the order to 350 to 500 : 1. Wood-inhabiting mushrooms such as *Pleurotus*, *Lentinula*, *Flammulina* etc. can metabolize large amounts of carbohydrates including lignin in the presence of a very small amount of nitrogen. Chang and Hayes (1987) uttered a mixture of rich organic materials was converted into a stable medium which was selective for the growth of particular mushroom but was not suitable, or was less favorable, for the growth of competing microorganisms through composting. Oh *et al.* (2003) selected a supplement fermenting sawdust substrate in previous work. In this study the findings designated that rapid fermentation and recycle of by-product were achieved in preparation of oyster mushroom substrate introducing the previous technique by Oh *et al.* (2003). The by-product of winter mushroom promoted activity of microorganism related with fermentation and shortened 3 days to complete the substrate more than control treatment (Fig. 3).

Formation of mushroom pin and yields. Mushroom mycelia were well developed in the fermented substrate, which promoted formation of mushroom primordia in a large lump. Oyster mushroom requires carbon source suitable for mycelial growth such as starch, glucose, pectin, cellulose and lignin (Kurtzman and Zadrazil, 1982). It seemed that the main purpose of fermenting was to provide mushroom mycelia with nutritions and environmental shelters from competing microorganisms. Based on good condition of mycelial growth, more comprehensive results would be established in the field of *Pleurotus* cultivation. Yields of oyster mushroom were obtained depending on the treated substrates. The highest yield was 742 g per 4 kg of substrate in the treatment of waste cotton with fermented poplar sawdust. There was a little difference in yields depending on each treatment except control treatment (Table 1). Though less yield in the winter mushroom by-product treatment was shown than fermented poplar sawdust treatment, it deserved recycling the by-product of winter mushroom in the process of making the substrate. In consideration related with substrate composition of oyster mushroom, supplements in waste cotton substrate played an important role in fermenting and raising the yields. Control treatment was lower yield than any other treatment in this experiment. It should be noted that this result has a possibility of adding supplements to *Pleurotus* substrate to raise yield without causing other problems. Oh *et al.* (2003) demonstrated that initial fruit bodies was promoted and activity of antibiotics was shown on the fermented substrate. In *Agaricus* cultivation, composting meant changes of substrate due to the activities of various microorganisms which resulted in the composted substrate being chemically and physically different from the starting material. However, In *Pleurotus* cultivation, it was quite different concept due to characteristics of mushroom mycelium which decomposed ingredient of wood tissue. It was thought that the recipe of the substrate was basically differentiated between oyster mushroom and botton mushroom.

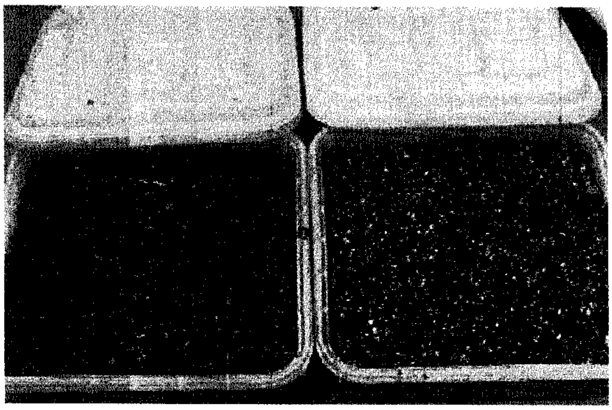

Fig. 3. Comparison of fermented substrates under the same condition during 5 days (left: control, right: waste cotton with fermented by-product of winter mushroom).

Table 1. Effect of substrates on the yield of fruit bodies obtained from box cultivation

Plots	Yield (g/box)
Control	663±90
Waste cotton with non-fermented poplar sawdust	708±57
Waste cotton with fermented by-procudt of winter mushroom	702±77
Waste cotton with fermented poplar sawdust	742±78

*Box size : 40 cm x 40 cm x 15 cm.

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