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YIELD EVALUATION OF PADDY STRAW MUSHROOMS (VOLVARIELLA SPP.) ON VARIOUS LIGNOCELLULOSIC WASTES

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ABSTRACT

In the present study, effect of various lignocellulose waste on mycelial growth and the yield of Volvariell spp. was studied. Volvariella spp., the paddy straw mushroom, is worldwide one of the most widely cultivated mushroom. Cereals are the most popular basal ingredient used in synthetic substrate formulation for producing paddy straw mushroom spawn. However, the present work evaluates the best and cheap substrate for spawn culture and mushroom production. Two species namely Volvariella volvaceae and Volvariella diplasia were experimentally evaluated on untreated organic wastes including rice bran, wheat bran, rice straw, sawdust, banana leaf and sugarcane baggage supplemented with wheat. Cultivation on wheat with rice bran resulted in significantly faster mycelial growth as compared to other substrates followed by wheat with straw in Volvariella volvaceae and wheat with wheat bran in Volvariella diplasia. With respect to fructification, culture on wheat with rice bran shows highest production in both the species of Volvariella . The lowest biological and economical yields were found when the culture was on wheat with banana leaf (Volvariella volvaceae) and wheat with sugarcane baggage(Volvariella diplasia). The above findings reveal an opportunity for commercial implication of paddy straw mushroom especially for utilization of different lignocelluloses waste.

KEYWORDS : *Yield evaluation, lignocellulosic waste, Volvariella spp, mycelium, growth.*

INTRODUCTION

Mushrooms are fleshy, spore-bearing reproductive structures of fungi. For a long time, wild edible mushrooms have played an important role as a human food. However, empirical methods for their cultivation are relatively recent (MartinezCarrera, 2000). They were independently developed in China about 1,000 years ago for Auricularia spp. and Lentinula edodes (Berk.) Pegler, and in France about 350 years ago for Agaricus bisporus (Lange)Imbach. During the last 50 years, these methods have been significantly improved. The technology of artificial cultivation of mushroom is somewhat recent innovation; incorporation of non conventional crops in existing agricultural system can help in improving the social as well as economic status of small farmers. In many countries, mushroom cultivation and its products yield a lot of income and enhanced dietary meals and improved health of the people (USDA, 2000; Mattila et al., 2001; Mau et al., 2001; Mau et al., 2002; Wasser, 2002; Chu, and Chow 2002 and Akpaja, et al., 2003). Mushrooms are good sources of sugars, fibre, proteins and minerals (Senatore, 1990 and Adewusi et al., 1993) with comparable amino acid with animal protein (Aletor , 1995). Mushroom protein is intermediate between that of animals and vegetables (Kurtzman, 1976). Mushrooms contain about 85-95% water, 3% protein, 4% carbohydrates, 0.1% fats, 1%

minerals and vitamins (Tewari, 1986).Mushrooms contain appreciable amount of potassium, phosphorous, copper and iron but low level of calcium (Anderson. and Feller, 1942). Mushroom also contain appreciable amount of Niacin, pantothenic acid and biotin (Subramanian, 1986). Cultivation of edible mushrooms is one of the most economically viable processes for the bioconversion of lignocellulosic wastes (Bano et al., 1993 and Cohen et al., 2002). Bioconversion of lignocellulosic residues through cultivation of Volvariella species offers the opportunity to utilize renewable resources in the production of edible, protein-rich food that will sustain food security for people in developing countries (Sanchez et al., 2002). The technology can also limit land and air pollution associated with burning agriculture wastes into the environment. The cultivation of Volvariella spp. has been tested in various agricultural byproducts as substrates for the cultivation of the paddy straw mushroom . . Some of this wastes/agro-waste includes banana leaves, saw dust, rice bran, wheat bran, sugarcane baggage (Tripathy, 1999), wheat and rice straw (Cangy and Peerally, 1995) .The majority of these substrates can be used as animal feed. However, their low digestibility, low protein content and high lignin content render them unpopular and unacceptable. Moreover, due to an increased demand on these substrates for biogas production, composting and non-availability in some areas, it becomes necessary to find cheap alternative sources.

MATERIALS AND METHODS

Collection and Storage of Volvoriella spp.

Stock culture of Volvariella spp. were obtained from "Trinath Mushroom Farm" at Jagadalpur during 2005 . Pure culture lines during the period of study were maintained on Potato dextrose agar (PDA) medium and inoculated at an interval of fifteen days.

Preparation of spawn and growth of Volvariella spp.

Various waste materials such as rice bran, wheat bran, rice straw, sawdust, banana leaf and sugarcane baggage were used for determination of suitable spawn substrate. The Wheat grain, were washed several times to remove any suspended particles. The grains were boiled in a container with water till they soften and then spread over a polythene sheet under shade for draining excess water from grains surface. Each substrate like rice bran, wheat bran, rice straw, sawdust, banana leaf and sugarcane baggage were soaked separately in water for about 8-9hour and than excess amount of water was drained out. Then 50% wheat grains and 50% rice bran, wheat bran, rice straw, sawdust ,banana leaf and sugarcane baggage(w/w) each were spread over a polythene sheet .20g of Calcium carbonate were added to 1kg of each combination and mixed together properly in a container (Sanchez et al., 2002). About 200g of each mixture was then transferred into a clean saline bottle. The bottles were plugged with non-absorbent cotton tightly, sterilized (22lb psi, 2hr) and cooled, inoculated with a pure culture mycelia and incubated at (23 ± 2)0 C for 10 days. The linear mycelial growth of mushroom was measured for each treatment. The un-inoculated sterile saline bottle (15cm length) with grains (up to 12.5cm length) was used as control.

Preparation of bed and growth of Volvariella spp.

Various agricultural wastes can be used in bed preparation. The present study was done with paddy straw. The tied paddy straw bundles were soaked in water for 12 to 16 hours and then kept in an inclined manner to remove excess water. Three soaked straw bundles with their butt ends one outside were placed lengthwise very close to each other on the bamboo frame. Then another set of three bundles were placed over them in similar manner but with butt ends on the opposite side and was the first layer. After 1st layer was completed, spawn bits of thumb size was put on the top of the layer .Same process repeated for five to six times but in opposite direction in each layer (Tripathy, 1999). The inoculated beds were covered with polythene sheet and incubated at 380 C to 400 C temperature for ramification of the mushroom mycelia. After full ramification, polythene sheet were removed and watering on bed was done twice or thrice a day. The number of pinhead development was recorded.

The harvesting was done in four flushes of one week intervals. After the 1st flush, the beds were watered and covered regularly to harvest 2nd, 3rd and 4th flushes.

RESULTS

Spawn of each mushroom mycelium was prepared using grain and various lignocellulose wastes. The average linear mycelial growth of individual mushroommycelium was noted from each of three replicates. Table 1 indicated the ability of wheat grain along with rice bran to facilitate faster mycelial growth of Volvariella volvaceae than other lignocellulose waste. Combination of 50% wheat and 50% rice bran had the shortest time for full mycelial growth (12 days) followed by combination of wheat and straw(13 days), were as wheat and straw took nearly two weeks (15 days) for full growth of mycelium. There was no significant difference between wheat, combination of wheat and wheat bran (18 days each) as it took 18 days for complete colonization on the substrate. Wheat and sugarcane baggage, wheat and banana leaf shows more than 21 days for complete ramification of the mushroom mycelia. From the Table-2 it was found that wheat grain along with rice bran shows faster mycelial growth(12 days) of Volvariella diplasia followed by combination of wheat and wheat bran(13 days), and then wheat and sawdust(16 days) for full growth of fungus. Rest of the combination shows more than 21 days for complete colonization of the mushroom mycelia. The effect of wheat grain along with different lignocellulose waste substrates on the yield of Volvariella volvaceae shown in Table 3 showed a little delaying response of three day more for pin head emergence in spawn combination of wheat and saw dust followed by wheat and wheat bran , wheat and straw , wheat and sugarcane baggage(7days). In case of wheat, it took only 5 days for pin head emergence. However, other substrates showed 5-6 days for complete pin head emergence. From the Table. 4 it was found that all the combination shows more than 7 days for pin head emergence whereas combination of wheat and rice bran and wheat alone showed 5 days for pin head emergence Volvariella diplasia. The biological efficiency was affected by substrate. Wheat and rice bran spawn resulted with highest Bio-efficiency in Volvariella volvaceae(13.6%) , Volvariella diplasia (12.4%) and the largest number of mushroom production. Wheat and banana leaf spawn yielded lowest with lowest biological efficiency (8.0%) in Volvoriella volvaceae and wheat and sugarcane baggage (7.6%) in Volvoriella diplasia. Significant yield variations were recorded on different substrates at first harvest. The highest number of mushroom (91) and economical yield was recorded with wheat and rice bran(1360g)in Volvoriella volvaceae and in Volvoriella diplasia ,the highest number of mushroom (99) and economical yield was recorded with the same combination(1243g). The economical yield decreases with decrease in average number of mushroom in other substrate. The lowest number of mushroom (40) and economical yield was observed in wheat and banana leaf in Volvariella volvaceae(500g) were as in Volvariella diplasia, the lowest number of mushroom (45) and economical yield was observed in wheat and Sugarcane baggage(760g).

Table 1: Effect of substrates on mycelial growth (cm) of Volvariella volvaceae per culture bottles after 7, 14 and 21 days.

Substrates	Days	Days	Days
	7	14	21
Wheat %	6.5 ± 0.2	11.0± 0.2	12.5± 0.1
50%Wheat + 50% Rice bran	10.0± 0.3	12.5± 0.2	12.5± 0.1
50%Wheat + 50% Wheat bran	6.2 ± 0.2	11.5± 0.3	12.5± 0.3
50%Wheat + 50% Straw	9.5 ± 0.2	11.5± 0.1	12.0± 0.2
50%Wheat + 50% Sawdust	9.0 ± 0.2	10.9± 0.2	12.5± 0.1
50%Wheat + 50%Banana leaf	3.5 ± 0.2	8.1± 0.3	11.8± 0.2
50%Wheat + 50% Sugarcane baggage	4.8 ± 0.3	9.8± 0.1	11.8± 0.2

Table 2: Effect of substrates on mycelial growth (cm) of Volvariella diplasia per culture bottles after 7, 14 and 21 days.

Substrates/Days	7	14	21
Wheat %	6.0 ± 0.2	11.3± 0.2	12.5± 0.1
50%Wheat + 50% Rice bran	9.8.± 0.3	12.5± 0.2	12.5± 0.1
50%Wheat + 50% Wheat bran	9.2 ± 0.2	12.5± 0.3	12.5± 0.3
50%Wheat + 50% Straw	8.5 ± 0.2	10.5± 0.1	12.0± 0.2
50%Wheat + 50% Sawdust	9.0 ± 0.2	10.6± 0.2	12.5± 0.1
50%Wheat + 50%Banana leaf	5.5 ± 0.2	8.9± 0.3	11.8± 0.2
50%Wheat + 50% Sugarcane baggage	5.8 ± 0.3	9.8± 0.1	11.8± 0.2

Table 3: Effect of spawn based on wheat grain with different combination of lignocellulose waste on fructification of Volvoriella volvaceae.

Spawn Substrate/Yields	Days for pin head emergence	Average no. of mushroom	Yield/Bed (g)	Bioefficiency (%)
Wheat %	05	80	1290	12.9
50%Wheat + 50% Rice bran	06	91	1360	13.6
50%Wheat + 50% Wheat bran	07	57	800	8.5
50%Wheat + 50% Straw	07	65	805	8.05
50%Wheat + 50% Sawdust	09	70	870	8.7
50%Wheat + 50%Banana leaf	06	40	500	5.0
50%Wheat + 50% Sugarcane baggage	07	75	960	9.6

Each value is mean of 3 replicates ± SEM

Table 4: Effect of spawn based on wheat grain with different combination of lignocellulose waste on fructification of Volvoriella diplasia

Spawn Substrate/Yields	Days for pin head emergence	Average no. of mushroo m	Yield/Bed (g)	Bioefficiency (%)
Wheat %	05	77	1211	12.11
50%Wheat + 50% Rice bran	05	99	1243	12.43
50%Wheat + 50% Wheat bran	07	78	1153	11.53
50%Wheat + 50% Straw	07	70	858	8.53
50%Wheat + 50% Sawdust	09	77	910	9.1
50%Wheat + 50%Banana leaf	07	58	810	8.1
50%Wheat + 50% Sugarcane baggage	07	45	760	7.6

DISCUSSION

The cultivation of edible mushroom using wheat and different lignocellulosic waste such as banana leaves, saw dust, rice bran, wheat bran and sugarcane baggage is a value added process as it gives base to growth of mushroom mycelium. Volvariella mycelia grows very well on a wide range of substrates, such as sugarcane baggage, waste tea dust, cotton wastes, oil palm pericarp wastes, oil palm bunch wastes, dry banana leaf and sawdust but their mean mycelia yields are comparably low in some of these wastes(Chen and Graham, 1973 and Chua and Ho, 1973) . Bolton and Blair 1982 and Fasidi, 1996, reported that rice husk is good for the production of V. esculenta because of its richness in oils and vitamins which are good stimulants for high mushroom yield. Substrate structure is an important factor for the growth of the mycelium as it should be suitable for penetration of the mycelium. Wheat is commonly used spawn for mushroom cultivation as it is cheaply and abundantly available and sustained faster growth rate of mycelium as compared to other substrates. Wheat grain alone takes nearly 18 days for complete ramification but supplemented with waste tea leaves gives faster mycelial growth and more yield than wheat alone (Bisht and Narsh, 1984). Supplementation of substrate has become one of the major aspects of mushroom cultivation. This is in order to boost the yield of mushrooms. Present study revealed that spawn made of wheat grains with rice bran sustained faster growth rate of mycelium as compared to wheat and other combination in both the Volvoriella spp. This implies that the carbohydrates present in different agro waste were more effectively utilized by the mycelium for better vegetative multiplication and sporophore yield. This support the report of (Zadrazil , 1993)who reported that supplements usually change the decomposition rate and the sequence of decomposition of substrate components during mushroom growth. Supplementation of substrates with different levels of carbon and nitrogen-based additives enhances mushroom production (Zadrazil , 1993; Royse et al.,1990; Royse, et al., 1991; Fasidi, and Kadiri, 1993; Royse, 1996, Isikhuemhen, et al., 1999, and Stamets ,2000). However, the lowest mycelial growth was found with wheat and banana leaf combination in Volvariella volvaceae and wheat and sugarcane baggage in Volvariella diplasia .This support the work of (Okhuoya, et al., 2005 and Quimio et al., 1990) and may be due to carbon to nitrogen imbalance in those combinations and secondly due to variation in concentration either above or below the required concentration that can promotes mycelial growth. The cultivation of edible mushroom using agricultural residues such as rice and wheat straw is a value added process to convert these materials, which are otherwise considered to be wastes, for mushroom production. Mostly in tropical countries agricultural waste plays a significant role in causing environmental pollution due to waste disposal problem. Wastes are either burnt or dumped nearby water bodies creating a health hazard to human life. Volvariella mycelium grows very well on a wide range of cellulosic wastes. Rice straw has been used for the indoor cultivation of paddy straw mushroom since the beginning of the 19th century, a practice from which the mushroom has been given the common name straw mushroom, and has been cultivated under natural conditions in many countries (Fasidi, 1996).Rice straw as the natural substrate on which V. esculenta grew and led to naming the mushroom as delicious straw mushroom was reported by Fasidi. Rice straw as substrate for mushroom bed is recommended for its cheapest quality and readily available in tropical countries. Volvariella volvaceae and Volvariella diplasia the yield potential of spawn raised on wheat grains and rice bran shows highest yield. The highest yield of V. volvaceae (1360g) and Volvariella diplasia (1243g) was obtained from wheat grain with rice bran. These results are in contrary to the report of Purkayastha et al. (Purkayastha, 1980) who reported that Volvariella spp. gave maximum growth and productivity on Wheat spawn. However the use of other combination as a spawn substrate may not be totally rejected as they are cheaper and easily available when compared to wheat grain. A higher Biological efficiency was observed in supplemented substrate support the work of (Fasidi, and Kadiri, 1993 and Royse, 1996) on Pleurotus tuberregium and Lentinus subnudu, respectively.

CONCLUSION

The highest mycelial growth was found in wheat with rice bran combination spawn and recommended commercially since it support sporophore production. The highest yield of V. volvaceae (1360g) and V. diplasia was obtained from wheat grain with rice bran. So the use of wheat grain supplemented with rice bran appears to be most suitable due to improved growth and sporophore production. Rice straw as substrate for mushroom bed is recommended for its cheapest quality and readily available in tropical countries. The production of mushrooms worldwide is increasing at an annual rate of about 10%. India is a agricultural country and rich in agricultural waste. The cultivation of Volvariella spp. on these agrowastes decreases the environmental problem and provide a sustainable means of adding value to the farmers. Further work is in progress to improve growing conditions of spawning and increase the yield of Volvariella spp on more feasible and cheap recyclable residue.

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