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Research Article

EFFECT OF FOOD PROCESSING WASTE ON THE GROWTH AND NUTRITION QUALITY OF *PLEUROTUS OSTREATUS*

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Abstract

Mushroom cultivation has been done with various substrates. In the present investigation, food processing waste from oat, soybean, and corn, peanut and green peas in the form of husk or shell was used as the supplement to the basal medium of straw for the growth of oyster mushroom (*Pleurotus ostreatus*). It was found that soybean supplement gave good results in terms of protein content, carbohydrate and calorific value.

Key Words: Mushroom, *Pleurotus sp*., nutrition, substrate, food processing waste.

Introduction

Mushrooms are being recognized as important food items from ancient times. Their usage is being increased day by day for their significant role in human health, nutrition and disease, Mushrooms especially *Pleurotus* sp. commonly called 'oyster mushrooms' are the second most popular mushrooms after button mushroom all over the world[1,2]. Edible mushrooms namely, *P. eous* has the highest percentage of protein content (46%) followed by *P. sajor caju* and *P. florida*. The fat content is highest in *P. florida* (1.9%) as compared to *P. sajor caju* (1.7%) and *P. eous* (1.2%). *P. eous* has the highest crude fiber content (12%) when compared to *P. florida* (11.5%) and *P. sajor caju* (10.9%)[3]. The basic substrates used for oyster mushroom cultivation were sawdust, rice straw and water hyacinth. The highest yield was observed for *P. sajor caju* and *P. columbinus* on rice straw. Sawdust was the second best organic substance tested followed by water hyacinth[4]. Artificial substrates were screened for cultivation of *P. tuber-regium.* The mixture of poultry droppings and topsoil produced fruit bodies that were relatively more in number and larger in size. The ones planted on only poultry droppings did not germinate but rather decayed[5]. The effects of various substrates on mycelia growth, colonization time,

primordial appearance time, mushroom yield, biological efficiency (BE), and size of the mushroom and chemical composition of *P. ostreatus* were analysed. Rice straw supplemented with 10% rice bran used as a control was found as the best substrate with yield (381.85 gm) and BE (95.46%) followed by rice plus wheat straw, rice straw plus paper waste[6]. Paddy straw mushroom (*Volvariella spp*.) can be cultivated using various ligno-cellulose wastes as substrates and also the effect in the mycelial growth of individual mushroom mycelium. Cultivation on wheat with rice bran resulted in significantly faster mycelial growth as compared to other substrates followed by wheat with straw in *V. volvaceae* and wheat with wheat bran in *V. diplasia* [7]. Shittake mushroom is generally cultivated on sawdust as a basal ingredient. The best sawdust requires need to be determined. Therefore shitake mushroom was cultivated on sawdust from the woody plants Babul (*Acacia nilotica* L.), Champa (*Michelia champaca* L.), Garzon (*Dipterocarpus alatus* Roxb.), Ipil-ipil [*Leucaena glauca* (Linn) Benth], Jackfruit (*Artocarpus heterophyllus* Lam), Mango (*Mangifera indica* L.), Raintree [*Albizia saman* (Jacq.) F Mull), Segun (*Tectona grandis* L), Shimul (*Bombax ceiba* L), Shisoo (*Dalbergia sissoo* Roxb) or mixtures of sawdust from all of the trees with equal ratio or rice straw to determine growth and fruiting characteristics. Jackfruit resulted in faster mycelia growth when compared to other. Surprisingly, rice straw did not produce any fruiting bodies. The lowest biological and economic yields were found when culture was on Champa[8].

Sawdust-based oyster mushroom (*P. ostreatus*) spent substrate (OMSS) could be recycled after fermentation with three probiotic lactic acid bacteria (LAB) strains as a feed supplement for post-weaning calves, and fOMSS (fermented sawdust-based oyster mushroom spent substrate) has the beneficial effects of an alternative to antibiotics for a growth enhancer in dairy calves[9]. The effect of five different substrates i.e paddy straw, wheat straw, mixture of paddy and wheat straw (1:1 ratio),bamboo leaves and lawn grasses on the production of edible Oyster mushroom (*P. ostreatus*) was studied. The earliest colonization was given by wheat straw and mixture of paddy and wheat straw. Wheat straw gave the highest yield. Non –enzymatic antioxidant activities were also obtained by estimating vitamins A, C and E. Oyster mushroom can be consumed as one of the source of non-enzymatic antioxidant vitamins[10]. Agro industry waste like bean stalk, reed grass, wheat straw, cotton waste, peanut shells and bean straw were used to study the growth parameters of *Pleurotus sp* and *Lentinula sp*. using solid state fermentation[11]. Fruit bodies of *P. tuber-regium* are universally used as food while sclerotia are used in Nigeria as food condiment and in medicine. Seven different substrates supplemented with fermented sawdust were used to produce mushrooms and sclerotia of *P.tuber-regium*. A mixture of river sand and

fermented sawdust substrate is recommended as the best substrate for the production of *P. tuber-regium* mushrooms while a mixture of corn waste and fermented sawdust substrate is recommended for sclerotial production[12]. The present study was carried out to study the effect of nutrient supplements like the processing waste of oat, corn, soy bean, peanut and green gram on the growth and nutrition of *P. ostreatus*.

Materials and Methods

In the present study oyster mushroom was cultivated using straw as the basal substrate which was supplemented with processing waste of oat, corn, peanut shell and soybean.

Collection of Mushroom spawn

The oyster mushroom spawn was procured from Mushroom cultivation, Virugambakkam, Chennai, Tamil Nadu.

Cultivation of mushroom

The basal media for mushroom was straw. The required amount of straw bundles (1 Kg/bag) was soaked in a tank of clean water for 12 to 16 hours. The straw bundles were removed from the water and kept in standing positions for 5 to 6 hours so as to drain out the excess water and to retain only 75 % moisture. The nutrient supplements 50 g each of dried and powdered corn husk, oat husk, soy bean nuggets and peanut shell were added to individual bags followed by the addition of the spawn. The bags were securely tied and placed in a dark room with ample moisture. The bags were moistened regularly and the growth rate was noted. A water sprayer was used to spray water at regular intervals to maintain the humidity inside the growth room. The control bags contained only straw and spawn.

Moisture Determination

Moisture was determined by LOD (Loss on Drying) method wherein the samples were initially weighed followed by placing them in the oven for one hour to obtain the final weight. The amount of moisture was calculated using the formula, Moisture content = initial weight- weight after drying. The biological efficiency was calculated as the weight of the harvested mushroom per bag/weight of dry substrate x100.

Determination of total protein

Five gram of the ground mushroom sample was taken with 50 ml of 1N NaOH and boiled for 30 minutes. The solution was cooled in room temperature and centrifuged at 1000× g using a table top centrifuge. The supernatant was collected and total protein content was measured according to the Biuret method[13].

Determination of total lipid

Total lipid was determined by a slightly modified method of[14]. Five gram of the ground mushroom sample was suspended in 50 ml of chloroform: methanol (2:1 v/v). The mixture was then mixed thoroughly and let to stand for 3 days. The solution was filtered and centrifuged at 1000× g using a table centrifuge. The upper layer of methanol was removed by pipette and chloroform was evaporated by heating. The remaining was the crude lipid.

Determination of crude fibre

Moisture and fat free mushroom sample was treated with 0.255N H_2SO_4 and 0.313N NaOH and then washed with ethanol and ether. It was then transferred to a crucible, dried overnight at 80-100̊C and weighed (W1) in an electric balance. The crucible was heated in a muffle furnace at 600̊C for 6 hours, cooled and weighed again (W2). The difference in the weights (W1-W2) represents the weight of crude fibre[15]. Crude fibre (g/100g) = [100-(moisture + fat)] × (W1-W2)/Weight of sample.

Determination of total ash

One gram of the mushroom sample was weighed accurately into a crucible. The crucible was placed on a clay pipe triangle and heated first over a low flame till all the material was completely charred, followed by heating in a muffle furnace for about 6 hours at 600̊C. It was then cooled in a dessicator and weighed. Then total ash was calculated as following equation: Ash content (g/100g) = Weight of ash × 100/Weight of sample taken[15].

Determination of total carbohydrate

The content of the available carbohydrate was determined by the following equation: Carbohydrate (g/100g sample) = 100 – (Moisture + Fat + Protein + Ash + Crude Fibre)[15].

Determination of metabolizable energy content

Fat, protein or carbohydrates can supply energy. Metabolizable energy is calculated using the following formula: ME (Kcal /100g) = [(3.5 X CP) + (8.5 X CF) + (3.5 X NFE)] Where, ME = Metabolic Energy; CP = % Crude Protein; CF = % Crude Fat; NFE = % Nitrogen Free Extract (carbohydrate).

Result and Discussion

The nutrient content and growth of Pleurotus ostreatus was studied. Among the food processing waste supplements, oat and soy bean waste gave significant results in relation to the growth of mushroom and hence was used for further analysis.

Peanut shell was found to give poor results in another experiment using solid state fermentation[11]. The moisture content in the mushrooms was analyzed and there was no significant change when compared to the control (Table 1). The spread of mycelium had initiated on the third day in the control and the treated bags and went on for about 10 days. The growth of fruiting bodies was faster in the control bags with oat (12 days) when compared to the oat (13 days) and soybean waste (14 days). The average size of a fruiting body was about 25 g in all the bags. The control bags yielded a total of 625 g of mushroom. The treated bags yielded slightly more than the control. The bags supplemented with oat husk yielded about 700 g and that of soybean waste gave a yield of 750 g (Fig 1).

Fig. 1 Growth of mushroom a) oat b) soybean.

Table-1: Moisture content in mushrooms.

Nutrient added	Moisture content (%)	Biological efficiency (%)
Control	86.2	62.5
Oat	86	70
Soy bean	85.8	75

The maximum protein content was seen in the mushrooms that were grown with the soy bean waste (24.5g/100g). Lipid content was observed to be more in the mushrooms that were grown without any nutrients in the control (4g/100g). Total carbohydrates was more in the mushrooms that were grown with the soy bean (40g/100g) as nutrient supplement and the metabolizable energy content was clearly the highest in the same (258.9Kcal/100g). The bags containing corn, peanuts and green gram as nutrients did not show significant growth.

Table-2: Nutritional analysis of mushrooms.

Nutrient	Total Protein (g/100g)	Total Lipid (g/100g)	Crude Fibre (g/100g)	Total Ash (g/100g)	Total Carbohydrate (g/100g)	Metabolizable Energy content (kcal/100g)
Control	20.6	4	27	8	37.4	237
Oat	23.5	2.6	26.8	7.4	39.2	241.55
Soy bean	24.5	3.9	26.2	8.3	40	258.9

Both the supplements showed an increase in protein, carbohydrate and metabolizable energy content. However, there was a slight decrease in lipid content when oats was used as supplement. Nevertheless, soybean might be considered to be a better supplement with respect to the higher calorific value.

Conclusion

Oyster mushrooms were grown on straw as a basal substrate supplemented with food processing waste of oats and soy bean. The mushrooms proved to be rich in protein with the highest yield of protein in the bags containing soy bean as the primary nutrient suggesting that it might be used as a nutrient supplement for oyster mushroom cultivation.

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