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Oyster Mushroom: Exploration of Additional Agro-waste Substrates in Nigeria

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ABSTRACT

Oyster Mushroom [*Pleurotus pulmonarius* (Fries) Quelet] was cultivated on agricultural wastes viz., cotton, rice straw, corn cob, corn husk and sawdust. This study examined growth of Oyster Mushroom on these substrates with a view to increasing the substrate options in the production of mushrooms. Rice bran was added as a nutritional supplement to each substrate. Fruiting bodies were observed on different agricultural wastes after two weeks of incubation. Data collected were diameter of the cap [pileus (cm)], length of stem [stipe (cm)] and dry matter of fruiting body [sporophore (g)]. The dry matter (32.4±1.5) and pileus (19.2±2.4) of cotton waste supplemented with rice bran (CR) was significantly higher ($p \le 0.0001$) while at the same level of significance, the stipe (18.0±1.2) for corn husk supplemented with rice bran (CHR) has significance difference compared with other substrates. The average width of the cap on the third day of appearance was highest for CR at 16% and lowest for Sawdust (S) at 6%; the average length of stem was highest for CHR at 15% and lowest for Corn Cob (CC) at 6% while dry weight was highest for CR at 27% and lowest for S at 2%. Supplemented substrates yielded better compared with non-supplemented substrates. CR was the best substrate followed by CHR while S was least. In addition to sawdust which is widely used by farmers, cotton waste, corn cob, husk and rice straw are possible agro-waste materials for oyster mushroom production.

Key words: *Pleurotus pulmonarius*, agricultural wastes, dry weight, additional substrates, supplement

INTRODUCTION

The Mushrooms industry in Nigeria is inchoate (Okhuoya *et al*., 2010). However, it is a growing industry. Cultivation and consumption is being encouraged especially with reference to nutritional, (Okhuoya *et al*., 2010) medicinal and nutraceutical (Afieroho *et al*., 2013) properties. Cultivation is also profitable in that it requires little space and is potentially an important means of increasing livelihoods of small scale farmers and land-owners (Adedokun *et al*., 2003). Species of *Pleurotus*-meaning side ear (Miles and Chang, 2004) are gilled mushrooms and are one of the most widely cultivated and eaten mushrooms. They are commonly referred to as oyster, abalone, or tree to mushroom.

Onyango *et al*. (2011) reported that many organic substrates are potential mushroom cultivation substrates. Similarly, Ghosh *et al*. (1998) reported *Pleurotus* species as edible mushroom, cultivated on ligno-cellulosic agricultural wastes for human consumption and that various species and strains of this fungus can utilize woody and non-woody materials efficiently by degrading their ligno-cellulosic ingredients. In Nigeria, majority of mushroom farmers use sawdust as bulk substrate. However, wood dust possesses toxicity and allergic effect with a long term hazardous effect on human health (Meier, 2013). This could result in health challenge to mushroom growers. Agricultural wastes if not utilized in mushroom production constitute environmental hazards and hideout for pests. Nigeria is the leading producer of maize in Africa, IITA (2013) with 9410000 tons; rice 4833000 and cotton 305000 (FAO, 2012). It is necessary to explore the potential use of the abundant agro-wastes as additional substrates for mushroom production.

The objective of this study was to examine growth of oyster mushroom on the test substrates with a view to increasing the substrate options in the production of mushrooms.

MATERIALS AND METHODS

Source of samples and study site: The Oyster mushroom *Pleurotus pulmonarius* spawn used in this study was obtained from the Federal Institute of Industrial Research, Oshodi, Lagos, Nigeria. Waste cotton (*Gossypium hirsutum*) was from the Atlantic Textile manufacturing Company, Lagos; rice (*Oryza sativa*) bran and straw from International Institute of Tropical Agriculture, Ibadan while corn (*Zea maize*) cob and husk were from Woji, ObioAkpor Local Government Area of Port-Harcourt, Nigeria.

The research was conducted at the post graduate laboratory of the Department of Plant Science and Biotechnology at the University of Port-Harcourt.

Cultivation protocol: Cultivation was according to the methods of Adedokun *et al.* (2003) as described below.

Mayonnaise transparent bottles of dimension (7.5×17×7.5 cm) were used as substrate containers. The substrates evaluated were waste Cotton (C), Rice Straw (RS), Corn Cob (CC), Corn Husk (CH), sawdust. Rice straw and corn husk were chopped into 5 cm pieces with a chop knife before use. The experimental design used was Completely Randomized Design (CRD) with 90% substrate and 10% Rice Bran (RB) as treatments replicated three times. Two hundred gram of substrates were measured, soaked in 100 mL distilled water containing 5% of lime ($CaCO_3$) for 30 min. Ten percent rice bran was added as nutritional supplement to each of the substrate.

The substrates were placed in the bottles and sterilized at 121°C for 15 min. After cooling, 10% of sterilized spawn was used for inoculation. Incubation was done at room temperature 28±2°C for two week. The bottles were opened for fruiting and sprinkled with water daily. After 6 days of watering, primordial initiation was observed. Diameter of pileus and length of the stipe were measured in centimeters with transparent meter rule and harvesting done three days after initiation. The fruiting bodies were weighed and then dried in an oven at 60°C for 3 days to obtain a constant dry weight.

RESULTS

Results of Oyster mushroom growth on the tested agricultural wastes are represented in Fig. 1-3.

Fruiting bodies were observed on different agricultural wastes after three weeks of inoculation with spawn of fungus and full mycelia colonization. Fruiting bodies grew well on cotton waste, corn cob, corn husk, rice straw as bulk substrates as well as on sawdust which is commonly used. The average width of the pileus of *P. pulmonarius* on the third day of appearance was highest for CR at 16% and lowest for Sawdust (S) at 6%; the average length of stem was highest for CHR at 15% and lowest for Corn Cob (CC) at 6% while dry weight was highest for CR at 27% and lowest for S at 2%. It is noteworthy that addition of supplement resulted in a higher dry weight than when none was added in the same substrate.

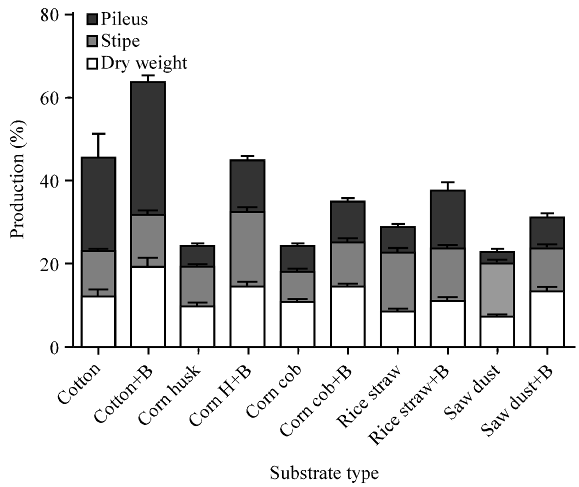

Fig. 1: Displays the growth of *P. pulmonarius* on substrates

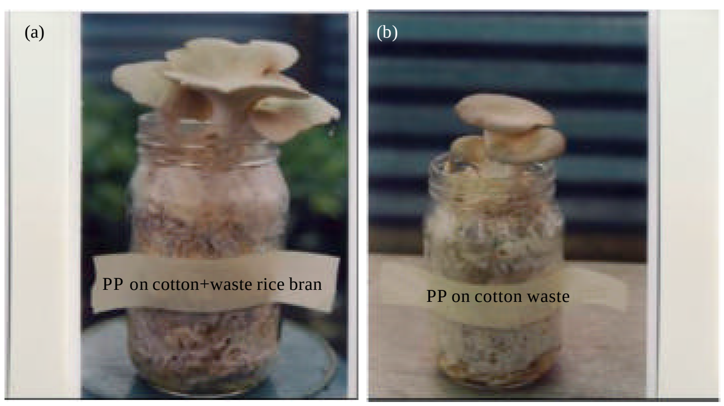

Fig. 2(a-b): (a) *P. pulmonarius* fruiting body growing on cotton supplemented with rice bran and (b) Cotton

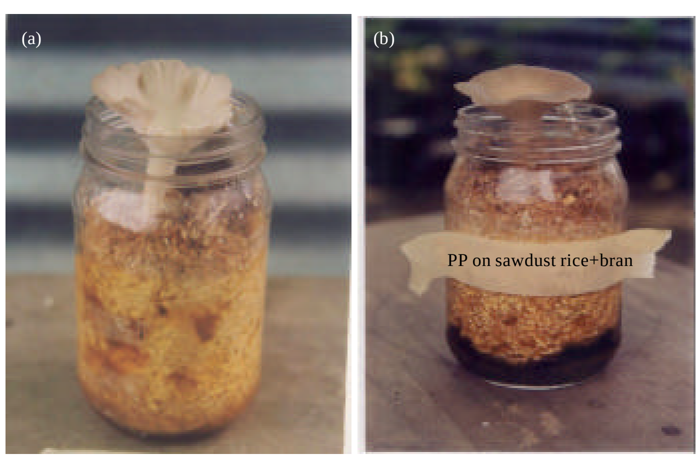

Fig. 3(a-b): (a) *P. pulmonarius* fruiting body growing on sawdust and (b) Sawdust supplemented with rice bran

There was significance difference ($p \leq 0.0001$) for the different parameters between the substrates. The dry matter and pileus of CR was significantly higher ($p \leq 0.0001$) while at the same level of significance, the stipe for CHR has significance difference compared with other substrates.

DISCUSSION

All the different agricultural wastes used in this study supported growth of *P. pulmonarius* indicating efficient bio-conversion of these agricultural wastes. The ability of *P. pulmonarius* to degrade these agricultural wastes makes it a useful tool in waste management as well as in nutrition. Akinyele *et al.* (2011) reported conversion of agro-wastes to useful biological products by Oyster mushrooms while Ghosh *et al.* (1998) observed that various species and strains of this edible mushroom are able to utilize woody materials and non-woody materials efficiently by degrading their ligno-cellulosic ingredients.

The growth of Oyster mushroom on these agricultural wastes (corn cob, cornhusk, rice straw, cotton waste) which have not been in use on commercial scale in the country further suggests that usage of these substrates if explored on commercial scale by mushroom farmers could possibly have triple advantage of food production, availability of mushrooms, reduction of agricultural wastes load on the environment (environmental health) and increase in livelihoods of farmers since there is increase in choice of substrates. Previous work which supported this view include Chitamba *et al.* (2012) and Sanchez *et al.* (2002). The technology can also limit air pollution associated with burning agriculture wastes (Ukoima *et al.*, 2009) as well as decrease rodents, pests and deleterious fungal inoculum populations. Furthermore, Buswell *et al.* (1996) recorded that various strategies have been developed to utilize part of the vast quantities of waste lingo-cellulose generated annually through the activities of the agricultural, forestry and food processing industries and one of the most significant, in terms of producing a higher value product from the waste, is the cultivation of edible mushrooms by solid state fermentation.

It is noteworthy that addition of supplement resulted in a higher dry weight than when none was added in the same substrate. This was also the case in the work of Adedokun *et al.* (2003). The highest percentage dry weight was on CR followed by C, CHR, rice straw supplemented with Rice Bran (RR), corn cob supplemented with rice bran (CCR), sawdust supplemented with Rice Bran (SR), CC, R, CH and lastly S. This can be attributed to variations in rates of ligno-cellulosic components resulting in reported yield differences. Enzyme production on each of the substrates as well as lignin- cellulose composition might have contributed to the observed result.

According to Buswell *et al.* (1996) utilization of lingo-cellulosic substrates by mushrooms is dependent upon their ability to synthesize the relevant hydrolytic and oxidative enzymes which convert the cellulose, hemicellulose and lignin into low molecular weight compounds that can be assimilated for nutrition. Production of these enzymes by the fungal mycelium is a crucial part of the colonization process and an important determinant of mushroom yields.

CONCLUSION

This study shows that apart from sawdust, other substrates (cotton waste, corn cobs, corn husk and rice straw) which are available in abundance could serve as substrates in mushroom production depending on availability of the agricultural products at various production sites and are recommended to farmers as potential substrates for Oyster mushroom production. Researchers are encouraged to compare nutritional contents of these substrates to that of sawdust in order to well inform farmers and the society.

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