Influence of Mixtures of Water Hyacinth Shoot Dry Biomass and Sawdust on the Growth and yield of *Pleurotus florida* (oyster mushroom)

Idowu O.O. and ✉Otunla C.A.
National Horticultural Research Institute, P.M.B. 5432 Idi-Ishin, Jericho, Ibadan, Nigeria.
✉Corresponding author: Otunla Caleb Adewale, +234 806 7438 116
e-mail: casotliz@yahoo.com

Accepted on May 8, 2014

Abstract
The need to boost production of edible protein sources for human consumption was the aim of this research study. This work also investigated the conversion of wastes to wealth by using sawdust and water hyacinth (Eichhornia crassipes) in Pleurotus florida production. Water hyacinth, a water weed, is a nuisance in our environment especially when rotten. In this study, P. florida (oyster mushroom) was cultivated on a mixture of chopped water hyacinth and sawdust. The experimental set-up was a complete randomized design (CRD) in three (3) replicates. Data were collected on growth and yield parameters. The parameters measured were number of fruiting bodies, fruiting bodies weight, average fruiting body weight, width of pileus, length of stipe, biological efficiency, production efficiency, days to full colonization, days to primordial initiation and average mycelia extension per day. Results obtained from this study revealed that sawdust alone, as substrate, gave the highest number of fruits (18.67). Similar trend was observed in fruit weight, length of stipe, mycelia extension per day, production efficiency and biological efficiency. The largest width of pileus was produced by water hyacinth alone (9.33cm) while the smallest was obtained from the substrate mixture of ratio 2:2. This result is an indication that sawdust alone is more productive, when compared with water hyacinth alone or in combination, for the cultivation of Pleurotus florida.

Keywords: Biological and Production efficiencies, *Pleurotus florida*, water hyacinth.

Introduction

A mushroom is a macro-fungus with a distinctive fruiting body which can be either epigeous (above ground) or hypogeous (underground) and large enough to be seen with the naked eye and to be picked by hand (Chang and Miles, 2004). Mushrooms are non-traditional horticultural crops having high quality of proteins, high fibre value, vitamins and minerals (Narayanasamy *et al*., 2009). Their use as food and delicacy is now assuming greater importance in human diets worldwide (Ogundana and Fagade, 1982; Akpaja *et al*., 2003). Mushroom is rich in protein, some essential amino acids, fiber, potassium and vitamins with low cholesterol and fat levels (Rafique, 1996). Mushroom cultivation represents the only current economically viable biotechnology process for the conversion of waste plant residues from forests and agriculture (Wood and Smith, 1987).

Oyster mushroom may be grown on wide range of plant wastes such as sawdust, paddy straw, sugarcane bagasse, corn stalk, corn cobs, waste cotton, leaves and pseudo stem of banana, water hyacinth, duck weed, rice straw etc. It does not require costly processing method and enrichment material (Bano *et al.*, 1979; Chow, 1980; Quimio, 1980). Sawdust

and sugarcane bagasse were the best substrates for growing oyster mushroom than other agro-based substrates (Ahmed, 1998).

At present, the commercial cultivation of edible and medicinal mushrooms on substrates formulated with lignocelulosic materials of different sources alone or mixed with other supplements is gaining popularity in Nigeria to overcome nutritional limitations and to provide suitable substrate structure and pH for the mushrooms (Lopez *et al.*, 2008). Therefore, the objective of this work is to investigate the influence of a combination of water hyacinth and sawdust on the growth and yield of *Pleurotus florida* as an alternative means of protein production.

Materials and Methods

This research study was carried out at the mushroom cultivation and production laboratory of the National Horticultural Research Institute (NIHORT), Idi-Ishin, Jericho, Ibadan.

Collection of Materials

The sawdust from *Gmelina aborea* wood used for this research work was collected at the Forestry Research Institute of Nigeria (FRIN), Ibadan while the water hyacinth (*Eichhornia crassipes*) was harvested at Epe in Lagos metropolis and sun-dried. A hand cutter was used to chop the water hyacinth into pieces of 3-5 cm. The spawn was obtained from the mushroom unit, NIHORT, Ibadan.

Preparation of desired spawn packet

Five treatments were used for the growth of *Pleurotus florida*. These were as follows:

S/No	SUBSTRATES	COMPOSITION
1	Substrate-1	Water hyacinth only
2	Substrate-2	Water hyacinth : saw dust = 3 : 1
3	Substrate-3	Water hyacinth : saw dust = 2 : 2
4	Substrate-4	Water hyacinth : saw dust = 1 : 3
5	Substrate-5	Saw dust only

The treatments were moistened until the moisture content was between 60 - 65%. They were filled into polyethylene bags with each bag weighing 300g and packed tightly. The neck of the bag was made with heat resistant PVC (Poly Vinyl Chloride) tube through which the spawn was introduced later. The opening was covered with a cotton plug. For about 30 minutes, these bags were sterilized in an autoclave at 121^{o}C, allowed to cool to the temperature of between 25^{o}C and 27^{o}C and aseptically inoculated with the spawn of *P. florida*. The treatments were replicated three (3) times and incubated for 30 days after spawning.

Collection of Data

The data collected were; number of fruiting bodies, fruiting bodies weight, average fruiting bodies weight, width of pileus, length of stipe, production efficiency, biological efficiency, mycelia extension, days to full colonization, primordia initiation and the average extension per day. The data obtained were subjected to ANOVA. Means were separated using Duncan's Multiple Range Test (DMRT).

Results

The result from the analysis of variance (ANOVA) revealed that different substrate mixtures had significant effects on the number of fruiting bodies, fruiting bodies weight, average fruiting body weight, width of pileus, length of stipe, production efficiency, days to full colonization, days to primordial initiation and biological efficiency. On the contrary, average extension per day was not significantly affected.

In terms of the number of fruiting bodies, saw dust alone (as substrate) gave the highest number (18.67). This was followed by the substrate mixture of water hyacinth and saw dust of ratio 2:2 (11.33). The least number was obtained from water hyacinth alone (4.67). This same trend was observed in the fruiting bodies weight. Here, saw dust alone produced the highest fruiting bodies weight (92.33g) followed by the substrate mixture of ratio 2:2 (58.67g) while the least (39.67g) was produced by water hyacinth alone (Table 1).

Table 1: *Pleurotus florida* yield on the mixtures of water hyacinth shoot dry weight and sawdust

Substrates	NF	FW (g)	Average fruiting body weight(g)	Width of pileus (cm)	Length of stipe (cm)
Water hyacinth only	4.67	39.67	9.18	9.33	3.53
3WH+1 SD	6.33	47.67	7.77	8.27	4.83
2WH+2 SD	11.33	58.67	5.23	5.13	4.37
1WH+3SD	4.80	43.00	11.21	5.33	3.90
Sawdust only	18.67	92.33	4.98	7.63	5.27
$LSD_{0.05}$	2.86	2.8	3.71	0.44	0.40

NF= Number of fruiting bodies, FW= Fruiting bodies weight, WH=Water hyacinth, SD= Saw dust

Similarly, the length of stipe was significantly longest (5.27cm) with saw dust alone, as substrate, followed by the substrate mixture of ratio 3:1 (4.83cm). The least was recorded in water hyacinth alone (3.53cm).

In contrast, the average fruiting body weight produced by water hyacinth alone was highest (9.18g). However, this was not significantly different from what was obtained from the substrate mixture of ratio 1:3 (11.21g). The least average fruiting body weight was produced by saw dust alone (4.98g). Similar observation was made with the width of pileus just as in the average fruiting body weight. The largest width of pileus (9.33cm) was produced by water hyacinth alone. This was significantly different from the one produced by the substrate mixture of ratio 3:1 (8.27cm). The substrate mixture of ratio 2:2 produced the smallest but it was however not significantly different from the one produced by the substrate mixture of ratio 1:3 (5.13cm and 5.33cm respectively). Both the production efficiency (P.E.) and biological efficiency (B.E.) were of the same trend. The highest percentage of B.E. (87.93%) was recorded with saw dust alone while the least (37.78%) was observed with water hyacinth alone, as substrates (Fig 1).

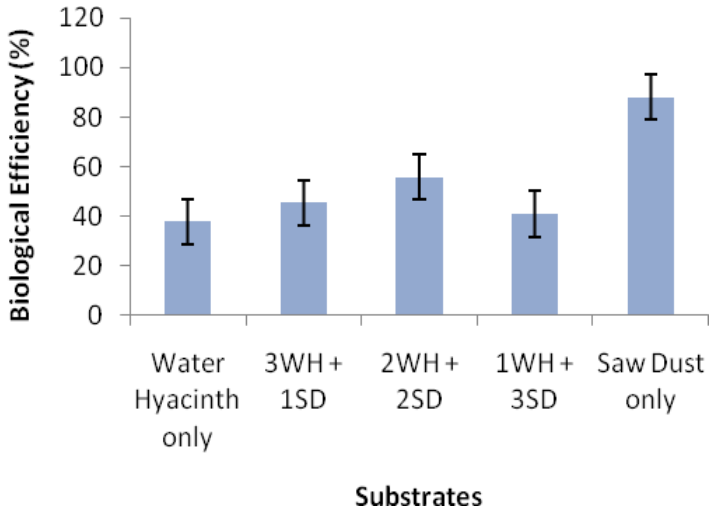

Fig. 1: Effects of the mixtures of water hyacinth and saw dust on the Biological Efficiency (%) of *P. florida*

WH= Water hyacinth, SD= Saw dust

The number of days for full mycelia colonization followed the same trend with primordial initiation (Fig 2).

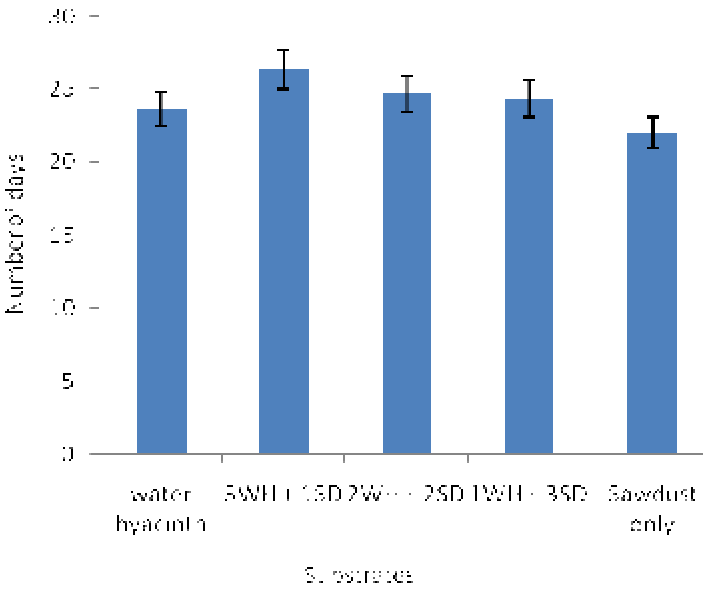

Fig. 2: Number of days to primordia initiation

WH= Water hyacinth, SD= Saw dust

The longest number of days for full mycelia colonization was observed in the substrate mixture of ratio 3:1(28.67 days) but not significantly different from the one recorded in the substrate mixture of ratio 2:2 (Table 2). However, the shortest was recorded in saw dust (25.33 days).

Table 2: *Pleurotus florida* growth on the mixtures of water hyacinth shoot dry weight and sawdust

Substrates	Production Efficiency (%)	Days to full colonization	Average extension per day (cm)
Water hyacinth only	16.00	26.33	1.20
3WH+1 SD	17.00	28.67	1.20
2WH+2 SD	21.05	28.00	1.20
1WH+3SD	17.22	27.00	1.20
Sawdust only	31.95	25.33	1.22
$LSD_{0.05}$	1.02	2.57	0.02

WH=Water hyacinth, SD= Saw dust

Discussion

For the growth and yield of the mushroom (*Pleurotus florida*) in this study, various values were recorded from the treatments. Mondal *et al.* (2010) recorded the maximum number of effective fruiting body on sawdust after rice straw, as a substrate, in a similar investigation. Higher number of effective fruiting body may be due to the presence of glucose, fructose and trehalose in the substrate, as reported by Kitamoto *et al.* (1995). Poppe (1973) found that Indole Acetic Acid (IAA) increased the number of fruiting body of mushroom. Furthermore, an increased surface area and availability of the saw dust components must have enhanced the number of fruiting bodies produced. This is also attributable to the highest fruiting body weight, longest length of stipe, highest production and biological efficiencies recorded with saw dust alone. The appreciable days to full mycelia colonization of oyster mushroom on different substrates might be due to variation in their chemical composition and C: N ratio as reported by Bhatti *et al.* (1987). The results recorded on all substrates were almost similar to the findings of Shah *et al.* (2004). He reported that the spawn running took 16-25 days after inoculation. Mondal *et al.* (2010) observed the lowest time (5.50 days) for primordial initiation on saw dust, as a control experiment which was statistically similar with banana leaves and rice straw in both (1:3) and (3:1) ratio. In a related research, Shah *et al.* (2004) found that the spawn heads appeared 6 days after the spawn running. Ahmed (1998) also stated that *P. ostreatus* completed spawn running (full mycelia colonization) in 17-20 days on different substrates and time for pinhead formation was noted at 23-27 days.

Conclusion

Sawdust alone may be concluded as the most suitable substrate for the cultivation of *P florida* (Oyster mushroom) in comparison with other treatments in this investigation. It gave the highest yields in terms of number of fruiting bodies, fruiting bodies weight, length of stipe, the production and biological efficiencies.

Acknowledgement

The authors express their deep appreciation to Mrs. Akinrinsola, F.O., Mrs. Majekadegbe, G.A. and Mr. Daropale, S. for their technical support.

References

Ahmed, S. (1998). Performance of different substrates on the growth and yield of Oyster Mushroom *Pleurotus sajorcaju* (Fr.) Sing. M.Sc. thesis, Department of Horticulture. Institute of postgraduate studies in Agriculture, Salna, Gazipur, Bangladesh.

Akpaja E. O., Isikhuemhen, O. S. and Okhuoya, J. A. (2003): Ethno-mycology and uses of edible and medicinal mushrooms among the Igbo people of Nigeria. *International Journal of Medicinal Mushrooms* 5:313 – 319.

Bano, Z., Nagaraja, N., Rajrathnam, S. and Pathwardhan, M.V. (1979). Cultivation of *Pleurotus spp*. In a village model hut. *Indian Fd. Packer*. 33(6): 9-25.

Bhatti, M.A., Mir, F.A. and Siddiq, M. (1987). Effect of different bedding materials on relative yield of oyster mushroom in the successive flushes. *Pakistan J. Agril. Res* 8(3): 256-259.

Chang, S.T and Miles, P.G (2004). Mushrooms: Cultivation, Nutritional Value, Medicinal Effect, and Environment Impact. CRC Press. Boca Raton. 415p.

Chow, L.P. (1980). Utilization of cotton waste substrate with temperature treatment for cultivation of oyster mushroom in Singapore, Singapore *J. Pri. Ind*. 8(10): 21-27.

Kitamoto, Y., Horkoshi, T., Hosio, N. and Ichikawa, Y. (1995). Nutritional study of fruiting-body formation in Psilocybe panaeoliformis. *Trans. Mycol. Soc.* (Japan). 16(3): 268.

López Castro, R. I., Delmastro, S. and N. R. Curvetto (2008). Spent oyster mushroom substrate in a mix with organic soil for plant pot cultivation. *Mycologia applicada international* 20(1): 17-26.

Mondal, S.R., M. J. Rehana, M. S. Noman and S. K. Adhikary (2010). Comparative study on growth and yield performance of oyster mushroom (*Pleurotus florida*) on different substrates. *J. Bangladesh Agril. Univ*. 8(2): 213–220.

Narayanasamy P, Suganthavel P, Sabari P, Divya J. and Vanchinathan M. (2009). Cultivation of mushroom (*Plerotus florida*) by using two different agricultural wastes in laboratory condition. *The Internet Journal of Microbiology* 7 Number 2 DO 1; 10.5580/ 2324

Quimio, T.H. (1980). Survey and culture of edible ones, In: cultivation of edible mushroom in tropics, UNESCO, Regional workshop, Manila.

Rafique, A. N. (1996). Studies on the Cultivation of Mushroom *Pleurotus species* in Gujarat. Ph. D. Thesis, Department of Microbiology. M.G. Science Institute, Navrangpura, Ahmedabad, India.

Ogundana, S. K. and Fagade, O. E. (1982). Nutritive value of some Nigerian Mushrooms, *Food Chemistry*.8: 263 – 268.

Poppe, J.A. (1973). The fruit regulating action of light and chemicals in the culture of P. spp (Fr.).*Medeligen, Vande Paculteit Landbouwweten sheappen*. 38(3): 1387-1397, (cited from Hort. Abst. 44(2): 1974-9737).

Shah, Z. A., Ashraf and Ishtiaq, M.C. (2004). Comparative study on cultivation and yield performance of Oyster mushroom (*Pleurotus ostreatus*) on different substrates (wheat straw, Leaves and Sawdust). *Pakistan J. Nutrition*. 3(3): 158-160

Wood, D.A. and J.F. Smith. (1987). The Cultivation of Mushroom. In essays in agricultural and food microbiology editor by Norris J.R. and Pettipher G.L. John Wiley and Sons Ltd. pp 310-343