Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol 2, No.3, 2012

Assessment of Growth Support Potentials of Different Substrates for the Cultivation of Volvoriella Volvaceae

Markson, Aniedi-Abasi A., Madunagu, Bene, Bassey, Glory

Department of Botany, University of Calabar, P.M.B. 1115, Calabar, Nigeria.
E-mail of corresponding Author: marksoncal@yahoo.com.

Abstract
Four substrates (banana leaves, sawdust, palm trunk fibre and coconut coir) were screened for the cultivation of straw mushroom (*Volvoriella volvaceae*). Palm trunk fibre and coconut coir substrates did not support spawning and fruit body production of the test mushroom. Proximate analyses of the composted and spent substrates revealed marked reduction in crude fibre and increase in the protein content of the spent substrates. Treatment of the substrates with $CaCO_3$ and rice bran increased the alkalinity of the banana and sawdust substrates. On banana leaves, spawn run took 21 days while sawdust substrate was totally colonized in 28 days. Pinheads appeared three days after transfer of the fully colonized substrates to the cropping room. Thirty one (31) flushes (each spanned 7 days) were recorded in 210 days. However, sawdust did not support the production of fruit bodies beyond the 24th flush which corresponded to day 161 from the initiation of pinheads. The biological efficiency was 19.93% for banana leaves and 10.05% for sawdust. The total fresh weight of fruit bodies produced from banana leaves and sawdust were 21.62kg and 10.91kg respectively. The mean length of stipe, area of pileus, fresh and dry weights of *V. volvaceae* cultivated on banana leaves substrate doubled those produced on sawdust substrate and were significantly different at $P<0.05$
Key words: Sawdust, banana leaves, nutrient composition, pH, *Volvoriella volvaceae.*

1. INTRODUCTION

Mushroom consumption dates back to years before the birth of Christ. Records have it that, 13000 years ago, Chile had associated with mushrooms (Aaronson, 2000). Romans and Greeks were known to place very high premium on mushrooms even as early as the 19th century (Buller, 1914). Over the years mushrooms have been collected and consumed as part of the daily meals in many parts of the world (Kumari *et al.*, 2008). However, these mushrooms were collected from the wild. The first documented evidence of mushroom cultivation was in China in AD 600 where wood ear mushroom, *Auricularia auricula* was cultured and later between AD 800 and 900, *Flammulina veluptipes* was grown. The cultivation of species like *Lentinus edodes*, *Volvoriella volvaceae* and *Tremella fuciformis* followed in AD 1000, 1700 and 1800 respectively (Miles, 1989). Mushroom domestication began in France in1707 with the cultivation of the white button mushroom (*Agaricus bisporus*) and at the end of the 19th century, multi-spore techniques for mushroom production was also developed in France. Within the period, the Japanese scientists were reported to develop methods to produce Shiitake mushroom from wood logs. And after the Second World War, cultivation of white button mushroom rapidly spread and reliable spawn

became commonly available in a number of countries (Oei, 2003). Today, mushroom cultivation has spread to many parts of the globe, and various methods of cultivation have been developed using a variety of substrates.

The level of involvement in mushroom cultivation in the African continent is not yet widespread and in Nigeria, it is sparsely done and at small holders' farm level (Okhuoya and Okogbo, 1990). The non-commercialization of mushroom farming in Nigeria is partly due to low or no acceptability of mushroom by the people as an important food source, hence, low patronage. Even in areas where there is a high demand for it, mostly the demands could not be met due to low productivity arising from application of inappropriate culture techniques. It is on record that many mushroom farmers in Africa and Latin America are secretive about their production strategies (Oei, 2003). Attempts have been made by a lot of researchers (Ukoima *et al.*, 2009; Kumari *et al.*, 2008; Belewu and Belewu, 2005; Fasidi and Kadiri, 1993) to bring such information to the notice of the mushroom farmers through workshops, seminars and publications. This study is aimed at boosting such efforts by giving insights into the appropriate and cost effective techniques of cultivating *Volvoriella volvaceae* (straw mushroom) using various substrate types. The contribution from this presentation will encourage commercial mushroom farming in Nigeria.

2. MATERIALS AND METHODS

2.1 Collection of materials

Dry banana leaves were collected from the University of Calabar farms. Sawdust was obtained from Government-owned timber market at Marian Hill, Calabar. Coconut coir and death palm trunk fibre were sourced from coconut traders and palm plantations respectively in Akpabuyo Local council area, Cross River State. The spawn was donated by Zartech farms, Ibadan, Oyo State, Nigeria. Rice bran was collected from private-owned rice mill in Itu Mbonuso, Ini L. G. A., Akwa Ibom State.

2.2 Substrate composition

Four substrates were composted namely: sawdust, dry banana leaves, coconut coir and palm trunk fibre. Sawdust was allowed to ferment for about 30 days. During this period it was turned regularly at 7 days interval. The fermented sawdust was soaked for 24 hrs. The banana leaves were shredded into bits of about $2cm^2$ and soaked for 12 hrs. These substrates were transferred to sac bags and drained of water to a moisture level of 70% using cassava press. Fifty kilograms (50kg) of each of banana and sawdust substrates were mixed with 0.4kg of $CaCO_3$ and 10kg of rice bran. The coconut coir was beaten into thin fibres and then cut into bits about 2cm long. Dead palm trunks were beaten into a homogenously fine sample. These materials were soaked in clean water for 12hrs. Pasteurization was achieved in sac bags using metal drums of about 500litres capacity with a wooden platform of about 35cm high within at $60\text{-}80^0$C for 6 hrs (Fasidi, 2006). Initial water level in the drum was 30cm from the bottom. The pasteurized substrates were allowed to cool for 12 hrs before bagging. Bagging was done in an axenic condition. Plastic bags measuring 30x25cm were used. Each bag was inoculated with 5g of *Volvoriella volvaceae*. The open end of each bag was secured with a PVC pipe 3cm long and 3cm in diameter wrapped with a rubber band and plugged with cotton wool.

2.3 Determination of pH and proximate analysis of substrates

Proximate analyses of the substrates were carried out on the fresh and spent mushroom substrates. Determination of nitrogen content was done using Kjeldahl method; Sodium (Na) and Potassium (K) was determined by flame photometric methods. Calcium (Ca) and magnesium (Mg) were obtained through EDTA extraction method. Mineral ash was determined by murfle furnace ignition method. The value for crude fibre was obtained by adopting Weeden method. Fat/oil was determined by Soxhlet Ether Extraction method. Carbohydrate and phosphorus content of the substrates were obtained by spectrophotometric methods (A.O.A.C., 1995). About 10g each of composted and non-composted samples of banana leaves and sawdust was crushed and dispersed in 10ml (wt/v) of distilled water separately. The setup in each case was shaken and filtered using four-fold muslin cloth to obtain the substrates filtrates. The pH level of the substrates were obtained using Agilent pH meter (Oei, 2003).

2.4 Spawn running

The bags were hanged with ropes serially from the roof down with each line carrying a maximum of five bags. Spawn running room was allowed limited light. Room temperature was about 30^0C and relative humidity between 65 and 75% achieved by spraying the compost bags and walls of the spawn running room 2 to 3 times daily with clean water (Fasidi, 2006).

2.5 Cropping and harvesting

At the end of spawn run, the bags of mycelial colonized substrates were transferred to the cropping room stacked on bamboo shelves and opened. This set up was sprayed with clean water after every 6hrs. The floor of the cropping room was covered with coarse sand from the sea bed and continuously moistened. The walls of the mushroom house were wetted regularly to humidify the environment to about 70%. On fruit bodies' formation and maturity, data were taken on area of pileus, length of stipe using conventional methods. Fresh weight was taken using Agilent electronic balance. Dry weight was obtained by drying the mushroom to a constant weight in Agilent oven and weighed with Agilent electronic weighing balance. Data were analyzed using SPSS version 14.0.

$$\text{Biological efficiency} = \frac{\text{Total weight of the fruit bodies}}{\text{Total weight of substrate (compost)}} \times \frac{100}{1}$$

3. RESULTS AND DISCUSSION

3.1 Determination of pH and proximate analysis of substrates

The pH levels of the composted and non-composted substrates were determined.. The untreated sawdust, coconut coir and palm trunk fibre were acidic. However, when sawdust was treated with $CaCO_3$ and rice bran, the pH nearly doubled increasing from 5.90 to 9.25. There was a very slight difference between the composted and non-composted coconut coir and palm trunk fibre. The difference in the pH value in each

case was slightly above 1. The pH of the untreated dry banana leaves substrate was alkaline (8.20) and when treated, the level of alkalinity increased to 9.70. Results obtained from the analysis of the four test substrates are shown in Table 1.

Proximate analysis of the substrates was carried out before and after mushroom cultivation (Table 2). Results obtained showed that in the spent banana leaves substrate, all the nutrients declined in amounts except for crude protein (CP) which recorded significant increase in quantity from 11.0% to 21.0%. The increase in crude protein level of the substrate may likely result from injection of fungal protein during the enzyme degradation process (Belewu and Belewu, 2005). Of the nutrient elements which showed decline in amounts, crude fibre and total carbohydrates were markedly reduced from 10.40 to 6.68% and from 68.12 to 64.40% respectively in banana leaves. Though similar observation was made on sawdust, the reduction in crude fibre (from 7.75 to 4.75%) and increase in crude protein (from 14.06 to 17.50%) content was less when compared with the values obtained for banana leaves substrate (Table 2). This is an indication that the ability of the test mushroom to degrade lignolytic and cellulolytic materials as well as carbon during its growth cycle (Mason *et al*, 1989) was less on sawdust than on banana leaves. The ease with which fungi degrade lignin and celluloses is partly a function of their ability to produce lignolytic and cellulolytic enzymes (Isaac, 1992) as well as the chemical content of the substrate they colonize. Oei (2003) reported that *V. volvaceae* utilizes more cellulose and less of lignin. The difference in the loss of crude fibre observed between banana leaves and sawdust treated to *V. volvaceae* may stem from inherent differences in the type and quantity of secondary metabolites contained in the two substrate materials. There is the likelihood that sawdust must have contained higher levels of antimicrobial constituents which may have slowed down the rate of cellulose solubilization and hence reduced fibre loss.

3.2 Spawn running

Of the four substrates tested, palm trunk fibre and coconut coir did not support the growth of the test mushroom, probably because of the acidity of these substrates. On banana leaves substrate, spawn run took 21 days while sawdust substrate was totally colonized in 28 days. The slow mycelial growth rate of the test mushroom observed on sawdust may not only result from the low nutrient content of the substrate but may also suggest the likelihood of the presence of high levels of growth inhibitory substances in the substrate. However, sawdust was not considered as adequate for the cultivation of *V. volvaceae* when compared with rice straw and banana leaves (Oei, 2003).

3.3 Cropping and harvesting

Pinheads appeared three days after transfer of the fully colonized substrates to the cropping room. Thirty one (31) flushes (each spanned 7 days) were recorded in 210 days. However, sawdust did not support the production of fruit bodies beyond the 24^{th} flush which corresponded to day 161 from the initiation of pinheads. The biological efficiency was 19.93% for banana leaves and 10.05% for sawdust. Oei (2003) reported a biological efficiency of 10% for banana leaves. That is 9.9% less than our value. The contrast may stem from the difference in the nutrient content of the dry banana leaves used, the materials and method of substrate composting as well as differences in other environmental factors. The total fresh

weight of fruit bodies produced from banana leaves and sawdust were 21.62kg and 10.91kg respectively. The mean length of stipe, area of pileus, fresh and dry weights of *V. volvaceae* cultivated on banana leaves substrate doubled those produced on sawdust substrate and were significantly different at $P<0.05$ (Table 3). The result of this study is intended to create awareness on the appropriate and cost effective techniques for mushroom cultivation in Nigeria. By this, government, private concerns and individuals are encouraged to embark on commercial mushroom farming to boost the country's economy and ensure food security.

REFERENCES

Aaronson, S. (2000) Fungi. In : Kiple K. F., ornelas K, C. (eds). The Cambridge history of food. the Cambridge, Uk. Cambridge University Press. 313-356.

Association Of Analytical Chemists (1995) Official methods of analysis Washington D.C. P. 21-116.

Belewu, M. A. and Belewu, K. Y. (2005) Cultivation of mushroom (*Volvoriella volvaceae*) on banana leaves. African Journal of Biotechnology. 4(12): 1401-1403.

Buller, A. H. R. (1914) The fungus lores of the Greek and Romans. Transactions of the British Mycological Society. 5:21-66.

Fasidi, I. O (2006). Substrate sourcing and preparation for mushroom cultivation. Training workshop on cultivation of tropical mushrooms 20th -22nd November, 2006 at University of Ibadan, Oyo State.

Fasidi, I. O and Kadiri, M. (1993) Use of agricultural wastes for the cultivation of *Lentinus subnudus* in Nigeria. Revista Biol. Trop. 41:411-415.

Isaac, S. (1992) Fungal-Plant Interactions. Chapman and Hall, 2-6 Boundary Row, London SEI 8HN. P.147-167.

Kumari, D. and Achal, V. (2008) Effect of different substrates on the production and non-enzymatic antioxidant activity of *Pleurotus ostreatus*. Life Science Journal. 5(3): 1-5.

Miles, G. P. and Chang, S. T. (1997) Mushroom basics: concise basics and current development. London, World Scientific publishing co. Ltd.

Oei, p. (2003) Mushroom cultivation: appropriate technology for mushroom growers. Leiden, The Netherlands. Backhuys publishing.

Okhuoya, J. A. and Okgobo, F.O. (1990) Cultivation of *Pleurotus tuber-regium*(Fr) Sing on various Farm wastes.Pro. Okla Acad. Sc. 71:1-3.

Ukoima, H. N., Ogbonnanya, L. O., Arikpo. G. E. and Ikpe, F. N. (2009). Cultivation of mushroom (*Volvoriella volvaceae*) on various farm wastes in obubra Local Government, oCross River State, Nigeria. Pakistan Journal of Nutrition. 8: 1059- 1061.

Table 1: The pH values of dry banana leaves, sawdust, palm trunk fibre and coconut coir substrates

Substrates	**pH**	
	Values	Scale
Dry banana leaves non-composted	8.20	Acidic
Dry banana leaves composted	9.70	Alkaline
Sawdust non-composted	5.90	Acidic
Sawdust composted	9.25	Alkaline
Palm trunk fibre non-composted	6.38	Acidic
Palm trunk fibre composted	7.60	Slightly alkaline
Coconut coir non-composted	6.40	Acidic
Coconut coir composted	7.80	Slightly alkaline

Table 2: Nutritional content of substrates used in the cultivation of *Volvoriella volvaceae*

	*Nutrients (%)										
Substrates	*Ash*	CF	CP	EE	CHO	Ca	Mg	K	Na	P	N
Dry banana leaves	*7.10*	10.40	11.00	3.90	68.12	4.42	1.97	0.70	0.20	0.18	3.92
Spent dry banana leaves	6.30	6.68	21.50	3.60	64.40	2.31	1.22	0.75	0.39	0.45	3.36
Sawdust	7.40	7.75	14.06	6.10	60.69	2.10	0.73	0.54	0.25	0.39	2.73
Spent sawdust	5.72	5.71	17.50	4.80	49.23	3.11	0.61	0.18	0.21	0.25	2.10
Palm trunk fibre	7.10	28.40	15.75	2.84	45.91	0.92	0.73	0.30	0.40	0.42	2.52
Coconut coir	8.10	10.84	17.75	9.40	53.91	1.06	0.67	0.46	0.66	0.79	2.84

*Values means of four determinations.

Table 3: Comparison of growth performance of banana leaves and sawdust substrates

	Growth parameters[a]			
Substrates	A	B	C	D
Banana leaves	*24.10**	291.10*	*69.70**	7.10*
sawdust	11.80	121.90	35.20	3.30
t-value	1.41	1.83	1.60	1.60

Values are means of 4 replicates

*Significantly different at P<0.05

[a]A = Length of stipe; B = Area of pileus; C = Fresh weight; D = Dry weight.