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Use of agricultural wastes for the cultivation of *Lentinus subnudus* (Polyporales: Polyporaceae) in Nigeria

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Abstract: *Lentinus subnudus*, a Nigerian edible mushroom is able to utilize a wide array of ligno-cellulosic wastes for vegetative growth and fructification. Of several substrates tested, *Andropogon tectorum* (Graminales: Gramineae) straw produced the highest mycelial extension. Supplementing substrates with 10% and 30% rice bran or milled cassava peels improved mycelial extension (30% was optimum). Fructification occurred on logs of *Spondias mombin* and unfermented compost comprising straw, rice bran, horse dung and $CaSO_4$.

Key words: Mushroom cultivation, growth, waste, food.

In Nigeria, edible mushrooms are highly priced, not only as food but also in traditional medicine (Oso 1977a). Mushrooms appear in traditional Yoruba artwork as the "tie dye" material of their traditional costume (Adenle 1985). Mushrooms also feature in Nigerian folklore and mythology (Oso 1977b).

Lentinus subnudus Berk (Polyporales: Polyporaceae) is edible and grows yearround on decaying logs in southern Nigeria. When harvested young, the fruitbodies are soft and brittle, but at full maturity they become tough, almost leathery. Some Nigerians relish the mature fruitbodies probably because they take a long time to chew and serve as a substitute for meat. Fasidi and Kadiri (1990 a) have shown that mature *L. subnudus* fruitbodies are rich in ascorbic acid, amino acids, protein, glycogen, sugar and lipids and that protein is their most abundant nutrient.

Since mushrooms are already widely accepted as food, the use of agricultural waste to produce them as an additional protein source will be a worthwhile venture. The present work screens lignocellulosic wastes which can support growth and fructification of this mushroom.

MATERIAL AND METHODS

The mycelial culture of *L. subnudus* was established by tissue culture of the pileus on malt extract agar medium. This was regularly subcultured thereafter.

Growth of mycelim on agricultural wastes: The wastes used appear in Table 1. One hundred grams of each waste material were soaked in 500 ml boiled water for 1hr and the excess water was manually squeezed through a muslin cloth. Each substrate was then packed into 3 boiling tubes. The boiling tubes were plugged with cotton wool, covered tightly with aluminium foil and sterilized at 121°C for 15 minutes. Each substrate was inoculated with 5mm disc of 5 day-old mycelium of *L. subnudus* and incubated at 30± 2°C for 11 days. At the end of incubation period, mycelieal extension was measured and density of mycelia on the various agricultural wastes was compared visually.

Effect of supplementation of wastes: Shredded dry straws of *Andropogon tectorum*, *Panicum maximum*, maize and rice, rice husk

TABLE 1

Mycelial extension and density of L. subnudus *on agricultural wastes, animal dungs and wild grasses, eleven days after inoculation (waste materials were shredded into 0.5 - 1 cm pieces)*

Substrates	Mean mycelial extension (cm)	Relative mycelial density
Andropogon tectorum straw	8.9a	8+
Banana leaves	6.5b	3+
Cassava peels	8.6de	9+
Cattle dung	-	-
Horse dung	4.5de	2+
Maize cob	6.9b	4+
Maize straw	3.8ef	5+
Panicum maximum Jacq. straw	5.0d	7+
Pennisetum polystachion (L.) straw	5.3cd	5+
Pig dung	-	-
Poultry dung	-	-
Rice bran	4.7d	9+
Rice husk	6.1bc	1+
Rice straw	3.1f	6+

Means followed by the same letter(s) are not significantly different at P+ 0.01 by Duncan's Multiple Range Test.

and shredded maize cob were used as substrates while rice bran and milled cassava peels at 10, 30 and 50% (w/w) levels were used as additives. Each mixture was soaked in boiled water for 1hr, squeezed to eliminate excess water, autoclaved for 15 minutes at 121°C, inoculated and incubated at 30± 2°C.

Cultivation of *L. subnudus:* In one experiment, six types of unfermented composts were formulated.

These were:

i. Rice straw (50%) + rice bran (30%) + horse dung (20% w/w)
ii. *A. tectorum* straw (50%) + rice bran (30%) + horse dung (20% w/w)
iii. Rice straw (60%) + rice bran (30%) + $CaSO_4$ (10% w/w)
iv. *A. tectorum* straw (70%) + rice bran (30% w/w)
v. Rice straw (70%) + rice bran (30% w/w)
vi. Maize straw (70%) + rice bran (30% w/w).

Each compost was prepared as usual and filled into 1.5 l, wide-mouthed flasks. Each flask contained 300g (w/w); flasks were tightly covered with aluminium foil, autoclaved at 121°C for 15 minutes and inoculated with 10g, rice straw spawn (produced by inoculating rice straw supplemented with 30% rice bran (w/w) with *L. subnudus* mycelium). The composts were observed regularly for fruitbody initiation after which the aluminium foil was removed for aeration.

In another experiment, *Spondias mombin* Linn trees were felled and sawn into logs (mean diameter, 10cm; length, 41 cm). They were sundried, soaked overnight in tap water and blotted dry. Three holes (3cm diameter and 5cm deep) drilled on each log at 12cm intervals, were filled with 10g. rice straw spawn and sealed with parafilm wrapper and candle wax. The logs wers kept in the greenhouse at 30±2°C and watered every other day.

RESULTS AND DISCUSSION

A. tectorum straw stimulated the highest mycelial extension, followed in order by maize cob, rice husk and *Pennisetum polystachion, P. maximum* and rice straws. Regarding mycelial density, rice bran and milled cassava peel were the best substrates. These were followed by *A. tectorum, P. maximum* and rice straws. Rice husk was the poorest and of all the dungs tried, only horse dung supported mycelial extension and density (Table 1). *L. subnudus,* and other mushrooms such as *Volvariella* and *Pleurotus* are able to utilize various cellulosic wastes. In a similar study Quimio (1981) found that *Auricularia* sp. can be cultured on a wide variety of agricultural wastes. The growth of

L. subnudus on different substrates may be due to its ability to secrete oxidising and hydrolysing enzymes (Fasidi and Kadiri 1990 b).

Rice bran and milled cassava peel as additives enhanced mycelial extension on rice husk, maize cob, maize, *P. maximum*, *A. tectorum* and rice straws (Table 2). The most stimulatory concentration of the rice bran was 30% but that of cassava peel varied according to substrate. For example 50% cassava peel stimulated the highest growth on *A. tectorum straw, maize straw, P. maximum* straw, and rice husk while on maize cob and rice straw, 30% cassava peel was the most stimulatory concentration (Table 2). As for mycelial density, 50% rice bran and cassava peel were the most stimulatory (Table 2).

The observed stimulatory effect on growth may be caused by carbohydrates, aminoacids and mineral elements common in rice bran (Bolton and Blair 1982) and by the soluble carbohydrates and mineral elements of cassava peels (Oyenuga 1968). Rice bran is rich in lipids and may stimulate higher mushroom yield because some fatty acids (especially linoleic acid) have been known as a yield stimulator for *Agaricus* primordium formation (Hayes 1972) and fructification (Schisler and Sinden 1966, Schisler 1967). Rice bran has also been known to be a good nutrient supplement to sawdust for mycelial growth of *Auricularia* sp. (Quimio 1981) and *L. edodes* (Han *et al.* 1981).

All the formulated composts supported fructification at 26.5°C with one or two flushes (Table 3, Fig. IA). Rice straw (60%) supplemented with rice bran (30%) and $CaSO_4$ (10%) supported the highest number of fruitbodies, and formed them earlier than the other composts (at 25 and 30 days for the first and second flushes respectively). *Pleurotus ostreatus, L. edodes* and *Agrocybe aegerita* were successfully fructified on a mixture of chopped corn cobs and rice straw (1:1) (Jablonsky 1981) while *Macrolepiota procera* fruitbodies were produced on a compost of rice straw or corn cob fortified with 2% wheat bran (Jandalk and Thianga 1981).

Logs of *S. mombin* inoculated with active mycelia of *L. subnudus* also produced fruitbodies in three flushes with the first flush at 160 days after inoculation (Fig. IB). The Japanese mushroom *L. edodes* as well as *Auricularia* sp have been successfully fructified on logs (Ishii

TABLE 2

Effect of rice bran and cassava peels as additives on mycelial extension and density of L. subnudus *on various cellulosic wastes*

	Mycelial extension (cm) Rice bran				Relative mycelial density Rice bran			
	0%	10%	30%	50%	0%	10%	30%	50%
A. tectorum straw	8.7bc	9.5a	9.9a	7.0d	5+	8+	10+	11+
Maize cob	8.0c	8.8bc	9.3ab	7.0d	4+	8+	9+	10+
Maize straw	3.0g	6.9d	8.1o	5.6e	2+	6+	8+	10+
P. maximum straw	4.3f	9.1ab	9.6a	9.6a	2+	8+	9+	10+
Rice husk	6.0gh	9.2ab	10.0a	8.3c	1+	7+	10+	11+
Rice straw	2.3j	6.2e	7.1d	5.7e	3+	6+	8+	10+
	Cassava peels				Cassava peels			
	0%	10%	30%	50%	0%	10%	30%	50%
A. tectorum straw	7.4d	8.4c	9.9a	6.9d	2+	6+	6+	6+
Maize cob	7.0d	7.9c	8.0c	8.1c	5+	6+	6+	6+
Maize straw	2.4f	4.8e	5.9de	4.0e	3+	6+	6+	6+
P. maximum straw	4.9e	9.4a	8.9b	8.7bc	3+	6+	6+	6+
Rice husk	7.0d	9.3a	9.6a	8.8b	1+	3+	4+	6+
Rice straw	2.5f	5.3e	5.4e	6.7d	2+	3+	6+	6+

Means followed by the same letter(s) are not significantly different at P= 0.01 by Duncan's Multiple Range Test.

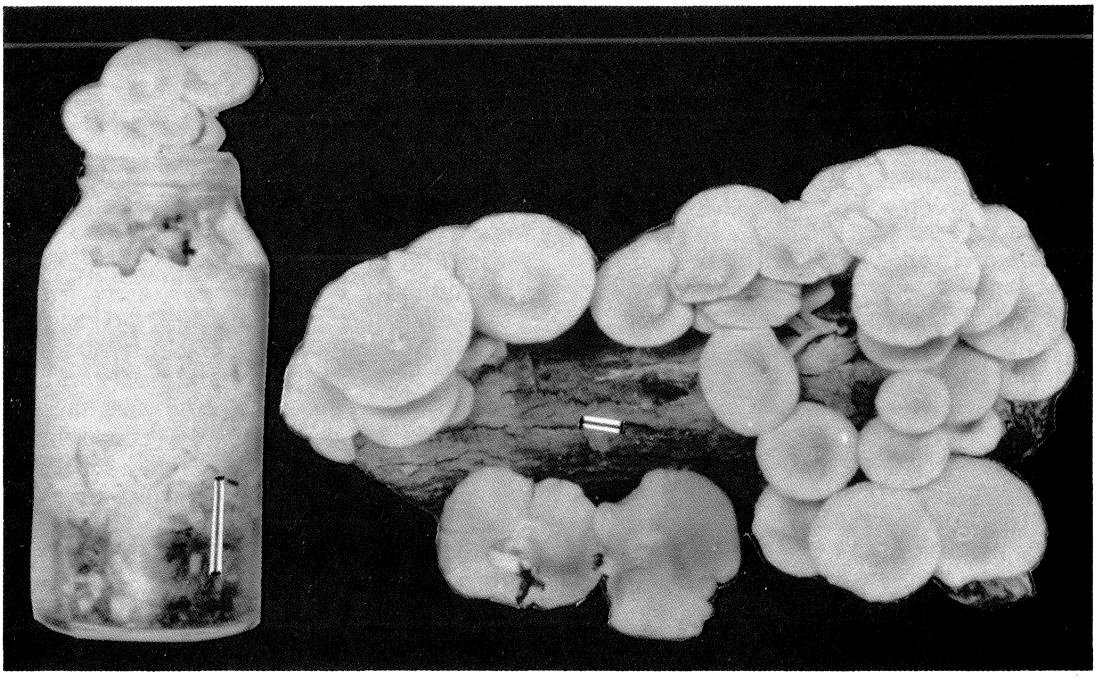

Fig. 1. *L. subnudus* fruit bodies produced on A (left) unfermented compost (rice straw 60%, rice bran 30%, $CaSO_4$ 10%, inoculated with 3% spawn) and B. (right) a log of *S. mombin* (also inoculated with 3% spawn). Scales: 3 cm.

TABLE 3

Fruitbody formation of L. subnudus *on unfermented composts*

Substrate composition	Time of primordia formation (days after inoculation		Time of fruitbody maturity from primordia (days)		No. of fruitbodies formed	
	A	B	A	B	A	B
Rice straw 50% + rice bran (30%) + horse dung (20%)	26c	46b	3	3	4c	5c
A. tectorum straw (50%) + rice bran (30%) + horse dung (20%)	25c	45b	4	4	5b	7a
Rice straw (60%) + rice bran (30%) + CaSO4 (10%)	25c	39b	3	3	7a	6b
A. tectorum straw (70%) + rice bran (30%)	45b	67a	3	3	4c	6b
Rice straw (70%) + rice bran (30%)	55a	-	3	-	2d	-
Maize straw (70%) + rice bran (30%)	59a	-	4	-	4c	-

A= First flushing. B= Second flushing.
Data are means of three replicates. Means followed by the same letter(s) within any column are not significantly different at P= 0.01 by Duncan's Multiple Range Test.

1972, Quimio 1981). From our results it is clear that *L. subnudus*, a delicious Nigerian mushroom, can be cultivated on local cellulosic wastes and logs. Industrial production will be considered in our next study.

RESUMEN

Lentinus subnudus, un hongo comestible de Nigeria, puede crecer y "fructificar" en varios desechos lignocelulósicos. La gramínea *Andropogon tectorum* produjo el mayor crecimiento miceliano. Al agregarse a los sustratos de cultivo salvado de arroz o cáscara molida de yuca al 10 y 30%, se mejoró el resultado (30% fue óptimo). La "fructificación" se dio en troncos de *Spondias mombin* y "compost" sin fermentar hecho con paja, salvado de arroz, boñiga equina y $CaSO_4$.

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