



Effect of Different Food Processing and Agricultural Wastes on Mycelia Yield of White Oyster (*Pleurotus ostreatus*)

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ABSTRACT: The mycelium makes up the thallus, or undifferentiated body of a fungus such as brackets, mushrooms, puffballs, rhizomorphs, *sclerotia*, stinkhorns, toadstools, and truffles. Mushrooms are fleshy fungi and there are edible or poisonous types. The edible mushrooms are consumed as food in different part of the world and are recognized for their ability to convert waste products into a protein-rich-food. In this study, different agro-allied wastes materials were used as substrates to grow *Pleurotus ostreatus* (White Oyster). The substrates include top forest humus, sawdust, ground nut shell, corn cobs, *raphia* inflorescence, cassava peel and fermented cassava chaff. Sawdust had the highest single mycelia yield of White Oyster producing 491.67±12.583g with Biological Efficiency of 49.167±1.2583% followed by top forest humus 426.67±20.8117g with Biological Efficiency of 42.667±2.081%. Ground nut shell, *raphia* inflorescence, cassava peel and fermented cassava chaff demonstrated low mycelia yield of mushroom with Biological Efficiency of 34.00±0.5%, 12.00±0.50%, 15.10±0.36% and 16.167±0.47% respectively. A 1:1 combination of corn cobs and sawdust has the highest yield of 495±10.00g. The study showed sawdust is the most suitable for oyster mushroom cultivation and should be encouraged to be employed for commercial production of mushrooms. Furthermore, the combination of Sawdust and top forest humus, sawdust and corn cobs substrates demonstrated high mycelia yield of mushroom.

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Mushrooms are macro-fungi that have spore-bearing and a fleshy fruiting body (Chowdhury *et al.*, 2015). Mushrooms are a fleshy fungi (Basidiomycota, Agaricomycetes) having a stem, cap and gills underneath the cap having an umbrella shape. Mushrooms are defined as fruit bodies of macrofungi (Nwoko *et al.*, 2018) and are recognized for their ability to convert waste products into a protein rich food (Mane *et al.*, 2007) thus, the need to engage in its cultivation is on the increase. Mushrooms are ideal meal for everyone as it has low in energy and fat

content with appreciable amounts of vitamins, minerals, dietary fibre and protein (Cheung, 2010). There are more than 14,000 types of mushrooms present throughout the world, around 3000 species have been reported as edible (Chowdhury *et al.*, 2015). Almost 700 species of mushrooms are found to have medicinal importance, and approximately 1400 species are identified to be toxic characteristics (Mowsumi and Chowdhury, 2013). The Oyster mushroom is one of the most widely cultivated mushroom species. Among all types of mushrooms,

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over 200 types belong to the oyster mushrooms (Zie *et al.*, 2021). Mushrooms are consumed in different forms like fresh, boiled, pickled, dried, powdered, canned, fried e.t.c. Its farming and/or cultivation have picked up a fast pace among contemporary entrepreneurs owing to its nutritional and medicinal benefits and low cost input with high output and good revenue. It has been reported that the oyster mushroom have more advantages over other mushrooms in terms of ease of cultivation, their role in biodegradation and bioremediation, extracellular enzymes production and nutraceutical production (Royse *et al.*, 2017). Hence, the Oyster mushroom is a potential tool in biotechnology. Their ability of secreting cellulolytic and lignolytic enzymes among others enzymes is a pointer that they can be used for biotechnological purposes (Sanchez, 2004). The Oyster mushrooms has been found to be grown on a wide range of substrates. A wide range of substrates including wheat straw, barely straw, sinar straw and saw dust, banana leave, bean straw were used for *P. ostreatus* cultivation (Mowsumni and Chowdhury, 2013). Therefore, the objective of this research was to investigate the effect of Top Forest Humus, Sawdust, Ground Nut Shell, Corn Cobs, *Raphia* Inflorescence, Cassava Peel and Fermented Cassava Chaff wastes on mycelia yield of White Oyster mushroom (*Pleurotus ostreatus*).

MATERIALS AND METHODS

The Substrates: The substrates used in the research are primarily wastes materials sourced from the immediate environment, Amai, the host community of Novena University. The selected substrates used in the research are a total of eleven (11) substrates which includes seven (7) individual substrates and four (4) combinations based on percentage of the individual substrates with ten (10) replicated experiments were used in the research.

The single substrates are:

- i. Top Forest Humus (TFH)
- ii. Sawdust (SD)
- iii. Crushed Groundnut Shell (CGS)
- iv. Crushed Corn Cobs (CCC)
- v. Crush *Raphia* inflorescence (CRI)
- vi. Crushed Cassava Peel (CCP)
- vii. Crushed Fermented Cassava Chaff (FCC).

The combined substrates are:

- i. The combination of Forest Humus and Saw Dust 50% each respectively (TFH+SWD), that is 500g each.
- ii. The combination of Crushed Corn Combs and Saw Dust 50% each respectively (CCC+SWD) that is, 500g each.

- iii. The combination of Cassava Peel and Saw Dust 50% each respectively, 500g each
- iv. The combination of Groundnut Shell and Saw Dust 50% each respectively, which is 500g each.

Sample: The mushroom sample is *Pleurotus ostreatus* (The White Oyster Mushroom).

Culture media: The microbiological culture media used in the research is Potato Dextrose Agar (PDA).

Other Research materials include: Other research laboratory materials used in the research includes: Water and Sorghum (guinea corn), Culture Box, Autoclave, Test tubes, Razor blades, Inoculation wire, Flame/Bunsen burner, Bottles, Masking tapes, digital scale, Cotton wool and Aluminum foil. The list is not exhaustive.

Source of Starter Culture (The Spawn)

The selected mushroom species was sourced from The Mycofarms Ltd, Benin City, Edo State, Nigeria.

Research Location: The research location is Novena University, Ogume, Amai Campus. Amai is in Ukwuani Local Government Area of Delta State, Nigeria. Ukwuani Local Government Area is of geographical coordinates 5.840371 and 6.241629 (Google Satellite Map, 2023). The people of Amai speak Ukwuani language. Amai, a town in Ukwuani Local Government Area of Delta State, Nigeria is located between longitude 5°30' and 6°00'N and latitude 6°00' and 6°20'E. It is bounded on the west by Umukwata, to the east by Ogume, on the south by Ezhionum and north by Obiaruku. The population of the area is increasing because of the higher institution, Novena University, a privately owned institution. The area has a flat terrain with a small stream locally called Okumeshi where the inhabitants get their water for domestic and other use. It experiences the equatorial hot and wet climate with almost uniform temperature throughout the year. The vegetation is the rainforest zone (Egbai, 2011).

Experimental Design: An eleven (11) by ten (10) replicates treatments was used to access the biological yield of the mushrooms. This will amount to 110 fruiting nylon bags for each species of mushroom to be cultivated and a total of 220 fruiting boxes for the research, 110 for white oyster and pink oyster respectively.

Construction of the Cropping Room: A cropping room was constructed using materials that would allow for light, ventilation and adequate temperature at 27±2°C (Okwulehie and Ogoke, 2013, Oei and

Nieuwenhuijzen, 2005). This was built with wood and net, and shelves or platforms for placing fruiting mushrooms nylon bags.

Final Stage/Harvesting: After two weeks (14 days) in the dark room, checking for development of mushroom clusters was carried out to check for colonization of the substrate by the mycelium. These were transferred to shelves in the growth room (production house) where there is proper ventilation and light. As they grow and mature with the cap tight on the stalk, I picked them by gently holding the base part of stalk with fingers, twisting and breaking them carefully from the substrate (Oei and Nieuwenhuijzen, 2005).

Growth Measurement: The number and size of the fruiting bodies from each specie-substrate component labeled appropriately and was recorded after harvesting, the value was added and their mean values calculated by the following ways:

Counting the fruiting bodies after harvesting each specie bunch from respective nylon bags.

Measuring the Pileus diameter or Stipe length in centimeter (cm) using a transparent plastic ruler from one edge of the pileus across the stipe to the other.

Weighing of the fresh and dry fruit-bodies with a scale with a calibrated pan.

Determining the Biological Efficiency (BE), that is, the percentage yield of mushroom per dry weight (g/kg) (Chang and Milles, 2004):

$$B.E = \frac{\text{Fresh wweight of mushroom}}{\text{Dry weight of substarte}} * 100$$

RESULT AND DISCUSSION

The results obtained shows that the Stipes length measured ranges from 4.0cm to 7.2cm, mean value being 5.75cm with a Pileus Diameter (PD) of 3.9-6.8cm mean value being 5.225cm grown in SD. This seems to be the highest mycelia yield observed across the substrates as shown in Table 1.

Table 1: Fructification showing Stipe Lenght (SL) and Pileus Diameter (PD) of *P. ostreatus* on single substrates.

Substrates	S.L.(cm) Mean±Std	P.D.(cm) Mean±Std
FH	5.2250±1.20381 ^a	5.0250±1.61529 ^a
SD	5.7500±1.40594 ^a	5.2250±1.2365 ^a
GS	5.0750±1.38894 ^b	3.9500±1.19304 ^{ab}
CC	5.3750±1.49304 ^a	5.0250±1.56498 ^a
RI	2.4250±0.86554 ^{ab}	2.5000±0.54772 ^{bc}
CP	2.7000±1.02956 ^{ab}	2.7250±0.59090 ^{bc}
FCC	6.2750±6.02405 ^a	2.9500±0.70000 ^{bc}

Values are means ± Standard deviation of triplicate determination values with the different superscripts within the column are significant at (P<0.05).

The highest range of Stipe Length was observed in CC+SD with 4.2-6.5 cm. This also have the highest Pilus Diameter of 4.3-6.2 cm as shown in Table 2.

Table 2: Showing the Stipe Length (SL) and Pileus Diameter (PD) of *P. ostreatus* on combined substrates.

Substrates	S.L.(cm) Mean±Std	P.D.(cm) Mean±Std
FH+SD	5.0500±1.18181 ^a	5.3750±0.86554 ^a
CC+SD	5.2000±1.02307 ^a	5.0750±0.87702 ^a
CP+SD	3.7500±0.91469 ^a	3.4000±0.78740 ^b
GS+SD	3.8750±0.53774 ^a	3.5000±0.85245 ^b

Values are means ± Standard deviation of triplicate determination values with the different superscripts within the column are significant at (P<0.05).

Saw dust, forest humus and corn cobs are the substrates with the top yielding mushroom in a descending order based on the values of the mycelial yield and Biological Efficiency as shown in Table 3.

Table 3: The mycelia yield and biological efficiency of *P. ostreatus* on Single Substrates

Substrates	M.Y.(g) Mean±Std	B.E.(%) Mean±Std
FH	426.67±20.817 ^b	42.667±2.0817 ^b
SD	491.67±12.583 ^a	49.167±1.2583 ^a
GS	340.00±5.000 ^d	34.000±0.5000 ^d
CC	409.67±5.508 ^c	40.967±0.5508 ^c
RI	120.00±5.000 ^f	12.000±0.5000 ^f
CP	151.00±3.606 ^e	15.100±0.3606 ^e
FCC	161.67±4.726 ^e	16.167±0.4726 ^e

Values are means ± Standard deviation of triplicate determination values with the different superscripts within the column are significant at (P<0.05).

From the results above, Sawdust, Corn Cobs and Top forest humus are idea substrates for mushroom cultivation as they have Biological Efficiency (B.E.) of more 40%. This is according to Gume *et al.*, 2013, who reported that substrates treatments recommended for commercialization of mushroom production should give B.E. of over 40%.

Conclusion: The choice of which substrates to be used in growing mushroom is of great importance as it significantly influence the productivity of the mushrooms for better growth, body development, yield and overall performance. In this study, treatments with sawdust, corn cobs and forest humus demonstrated to be the best choice of substrates. Substrates such as cassava peel and fermented cassava chaff obtained lower growth and yield of mushroom. Further research and studies could be carried out on the effects of mixing other substrates other than the ones used in this experiment and varying the proportions as well.

Conflicts of Interest: The authors declare that there are no conflicts of interest regarding the publication of this article.

Data Availability: The data used to support the findings of this study are available from the corresponding author upon request.

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