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THE EFFECT OF DIFFERENT SUBSTRATES ON THE GROWTH AND YIELD OF OYSTER MUSHROOM (*PLEUROTUS OSTRATUS*)

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ABSTRACT

The study assessed the effect of sawdust and corn cob substrates on the yield of *Pleurotus ostreatus* with the aim of comparing the various growth parameters on the different substrates. The results obtained showed that the mean fresh weight of mushroom from sawdust gave 95g while the mean fresh weight from corn cob gave 45g. The mean dry weight of mushroom from sawdust gave 10g while that of corn cobs gave 4g, moisture content (MC) was also higher in mushroom harvested from sawdust while it was less in mushroom harvested from corn cobs with 85g and 41g respectively. Cap diameter of harvested mushroom was 6cm in sawdust and 4cm from harvested corn cobs. The strip diameter was 7cm on the sawdust while it was 4cm on the corn cobs. Cultivation of *Pleurotus ostreatus* from sawdust substrate showed the possibility of high growth and yield of *Pleurotus ostreatus* compared to corn cob substrates. It is therefore recommended that it is preferably to use more of sawdust substrate than corn cobs substrate for the cultivation of *Pleurotus ostreatus.*

Keywords: Growth, Mushroom, Substrates, *Pleurotus Ostreatus* Corn Cobs, Sawdust.

I. INTRODUCTION

A substrate is defined as any substance on which plants grow, it is also described as the surface or material on which an organism grows or obtains nutrients and nourishment. Thus even the soil can be viewed as a substrate, log of woods, a container with water that allows growth, wood shelling's, etc. can all be viewed as substrates. The main functions of a substrate are generally providing plant anchorage and delivering water, nutrients and oxygen to the roots.

A substrate is a surface on which an organism is attached or grows. Soil is the universal substrate for growing plants, but the majority of substrate growers look to develop a better medium specific to their plants.

A sawdust is a micro waste or a polarised wood products from both primary and secondary conversion irrespective of cutting method, sawing or sawmilling.[1]

Sawdust despite proven as a good substrate for mushroom production still possess some limitations mostly due to shortages as a result of sawmill closure and deforestation. Wheat bran being a very good substrate has also been regarded to be expensive for mushroom production.

Mushroom is defined as a macrofungus with a distinctive body which may be above ground (epigeous) Or below ground (hypogeous). They are members of higher fungi belongings to class basidiomycetes and some are Ascomycetes.[2] Like plants, fungi have a distinct cellular structure but they lack the most important feature of plants, the ability to use energy from the direct sunlight through chlorophyll.[3] Therefore, relying on sawdust and wheat bran alone as a substrate for mushroom production may lead to depressed production.

Mushrooms are fleshy saprophytic fungi, and it can be found growing on damp rotten log of wood trunk of trees, decaying organic matter and in damp soil rich in organic substances. Edible mushrooms are highly nutritious and can be compared with eggs, milk and meat.[4]

Oyster mushroom is an edible mushroom having an excellent flavour and taste. P. ostreatus has received increased attention for applications in bio-bleaching and the catalysis of difficult chemical conversions in the paper industry, textile dye decolorization, and detoxification of environmental pollutants[5]. Oyster mushrooms are prized for their exclusive flavour and deliciousness. They are rich in proteins, contain less fat, less carbohydrates, salt and rich in fibres and have high vitamin B12 and folic acid which are uncommon in vegetables. High availability of lysine and tryptophan and other amino acids usually absent in cereals make them ideal for food for patients suffering from hypertension, diabetes and obesity[6].

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II. METHODOLOGY

2.1 Study Area

The study was carried out at the mycology laboratory, Department of Plant Science and Biotechnology, Faculty of Science, University of Port Harcourt, Rivers State.

2.2 Source of Different Substrates

Sawdust and corn cobs which are the major substrates were sourced from Delphi Farms Auchi, Edo State, Nigeria.

2.3 Materials and methods.

The materials used in the projects are as follows:

Sawdust

Corn cobs

Leather bags

Manure

Calcium carbonate ($CaCO_3$)

Pleurotus Ostreatus spawn

2.4 Propagation Procedures

2.4.1 Mycelia Preparation (Spawning)

The 200g of irish potato was peeled, boiled in 500ml of water and 50g of agar powder and 50g of glucose D were added to the water and sterilized for 15 — 20 minutes in a conical flask. The medium (PDA) was poured into a well cleaned sterilized petri dish. Upon cooling, a tissue of the mature *Pleurotus ostreatus* fruiting body were cut and inserted into petri dish containing the Potato Dextrose Agar. After 3 to 4 days, the mycelia of *P. ostreatus* were seen growing from the cultured tissues in the petri dish.

2.4.2 Determination of Morphology Parameters

Cap diameter: This were determined by placing a transparent ruler across the center of the pileus of each harvested mushroom fruit body and reading off the diameter.

Stripe length: This were determined by placing a transparent ruler along the length of each fruit body stripe.

Weight of fresh fruit bodies. This was determined by weighing each fresh fruit body immediately after harvest using a portable digital balance.

2.4.3 Preparation of Different Substrates (Sawdust and Corn Cobs)

2.4.4 Sawdust Preparation

Sawdust (5kg) were weighed and 10 litres of water were added and properly mixed to homogenize the components. It was then bagged using a doubled white cellophane and bulked in a tight way so as to make the sawdust formed and strong. Four (4) replications were made from each substrate, 5 kilograms in each bag. Tags were made on the bags for clear identification and differentiation. The mouth of the cellophane were passed through a small rubber ring so as to create a little opening in the cellophane using a rubber band to bind the cellophane mouth properly. After which a perforating stick were used to create a hole of 10cm in the substrate bag and were covered with cotton wool and it was replicated 4times.

2.4.5 Corn cobs Preparation

The same method and measurement used for the preparation of sawdust substrate were also used for corn cobs substrate preparation.

2.4.6 Sterilization of Substrates Bags

Approximately 10 litres of water were turned into a sterilization drum, 5 substrate bags were arranged in the drum and allowed to heat on a gas cooker at a temperature of 100^{c} for 4 hours for sterilization. After turning off the gas cooker the substrates bags were left overnight and were removed the following morning. And it was air dried for 1 hour before inoculation[7].

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2.4.7 Inoculation

Sterilization of inoculation chamber and substrate bag with ethanol, the bottled spawn which was kept in incubation room for 2 weeks were fully ramified. The cotton wool use to cover the substrate bag were removed, and the spawns were turn in each of the substrate bag after which it was covered back with cotton wool and kept in the incubation room 3-4weeks. All other apparatus, equipment, metallic instruments, glass wares and culture media were sterilized locally in a drum. The culture room were cleaned by washing with detergents followed by 70% ethyl alcohol.

2.4.8 Incubation

The substrates were incubated at room temperature 28 ± 2^{0}C, for 4 weeks, after which it was transferred to the fruiting room.

2.4.9 Fruiting and Harvesting

Fruiting of mushroom took six (6) days while harvesting was done after ten (10) days of inoculation making use of razor blade.

2.5 Data Collection

Data were collected on fresh and dry weight of mushroom from the two different substrates (sawdust and corn cobs).

2.5.1 Morphological data collection

The growth and yield of P. ostreatus on the different substrates were determined by recording the number, weight and size of the fruiting bodies after sprouting. The measurements from the various replicates were added and their mean value calculated. The following parameters of growth and yield were measured. From three bags of each treatment and replicates of the two species were sampled by measuring the growth and yield parameters thus.

2.5.2 Yield Count: The yield count of P. ostreatus were taken by counting the fruiting bodies from each bag.

2.5.3 Biological yield: The biological yield were obtained by taking the total fresh weight of the fruiting bodies per bag. The average for the five bags from each substrate type were calculated and recorded.

2.5.4 Biological efficiency: It was calculated as the weight of fresh mushroom as a percentage of the dry weight of the substrate.

2.5.5 Time required for harvest: Time taken for harvest were done for the two sample bags from initiation stage to the time of maturation of fruiting body. The average of the time taken for primordial initiation and the time taken for harvesting were calculated and recorded.

2.5.6 Number of total effective fruiting body: The number of effective mature fruiting body were counted just before harvesting were done for the five sample bags. The average number of fruiting bodies for the five bags were calculated and recorded. Effective fruiting bodies are considered as the total number of completely matured mushroom per bag.

2.5.7 Height of fruit bodies

This entails measuring the distance from the substrate where the stalk starts growing. The height were measured in centimeters using transparent ruler from the base of the stipe to the pileus. The height of the stalk were carried out for at least three fruiting bodies for each of the three bags of the particular treatment. The average height were recorded.

2.5.8 Moisture analysis

Twenty gram of fresh mushroom were weighed into a weighed moisture and dried in an oven at 100 to 105°C and cooled in a desiccator. The process of heating and cooling were repeated till a constant weight were achieved. The moisture content of mushroom were also expressed in percent and calculated by the formula;

$$\text{Moisture content (\%)} = \frac{\text{Weight of fresh sample} - \text{Weight of dry sample}}{\text{Weight of fresh sample.}} \times 100$$

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2.5.9 Yield Attributes

The yield attributes are the weight of the mushroom before and after drying, (Fresh and Dry weight), the Moisture content, the average cap diameter and the strip diameter measured and were compared between both substrates.

III. RESULTS AND DISCUSSION

3.1 The Yield of *Pleurotus ostreatus* Grown on the Different Substrates

The table below shows the yield of the mushrooms as counted from each of the five bags of the different substrates labelled A to E. This includes fully blown mushrooms and spawns.

Table 3.1 Yield count

S/No.	Bags	Saw dust	Corn Cobs
1	A	18	28
2	B	15	24
3	C	20	32
4	D	15	24
5	E	22	19
6	Average	18	26.2

After the count, it was found that the Corn cob substrate had more mushroom yield than the Saw dust substrate. However, it was noticed that the Saw dust substrate had more quality yield than the corn cob substrate.

3.2 Biological Yield

Table 3.2 Total fresh weight of the fruiting bodies per bag

Bags	Fresh weight of Mushroom from Sawdust (G)	Fresh weight of Mushroom from Corn Cobs (G)
A	95	45
B	105	35
C	110	44
D	84	36
E	121	40

The total biological weight of the fruiting bodies from each bag were taken and as shown in the table above. The biological yield for P. Ostreatus in Sawdust were all higher than the yield from Corn cob.

Table 3.3 Biological Efficiency.

Bags	Weight of dry Sawdust Substrate (kg)	B.E of Mushroom from Sawdust (%)	Weight of dry Corn Cob Substrate (kg)	B.E of Mushroom from Corn Cobs (%)
A	3.0	3.16	2.8	1.6
B	2.8	3.75	3.1	1.1
C	3.0	3.67	3.0	1.5
D	3.0	2.8	3.0	1.2
E	2.9	4.17	3.0	1.3

The weight of the dry sawdust (in kg) was converted to grams and calculated as a percentage of the dry weight of the sawdust. It was seen that the Biological efficiency of P. ostreatus in all the Sawdust substrate bags were higher than that of P. ostreatus in all the corn cob substrate bag.

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Table 3.4 Time Required for Harvest

Bags	From Sawdust (Days)	From Corn Cobs (Days)
A	27	25
B	25	26
C	25	27
D	26	27
E	26	25
Average	**26**	**26**

The time for harvest was determined as the time from planting to the time taken to harvest at least 10 fully fruited P. ostreatus. The average time of harvest was calculated at 26 days for both substrates.

3.5 The number of fruiting bodies

The number of fruiting bodies for the Sawdust substrate was less than that sourced from the corn cob substrate as illustrated in fig. 3.1 below.

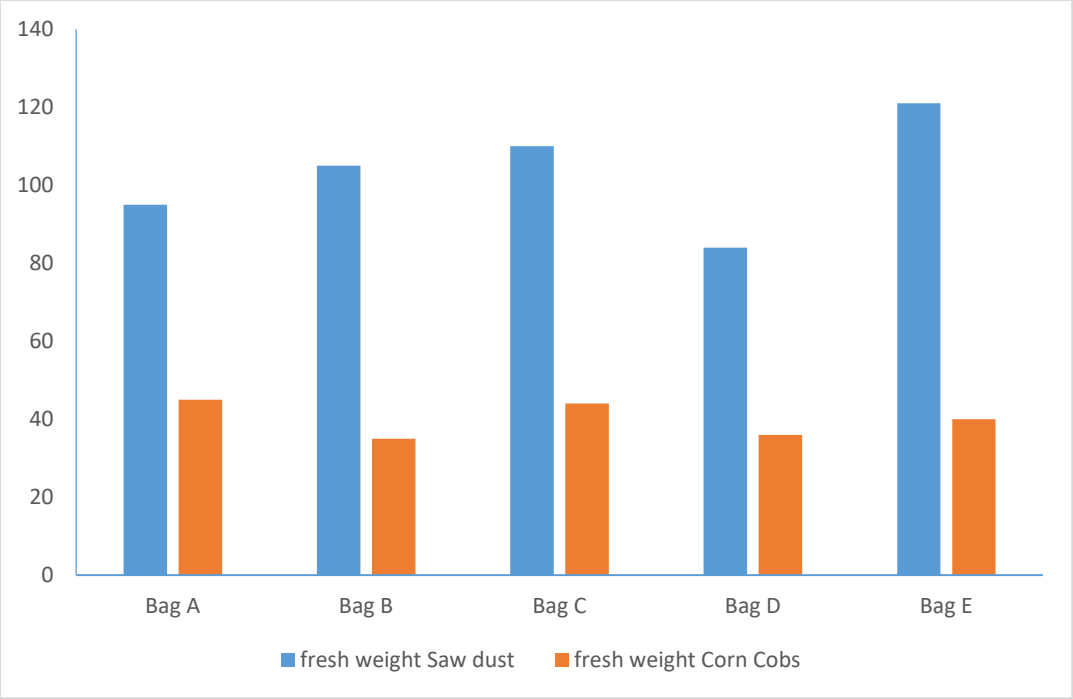

Fig. 3.1. Total Effective Fruiting bodies

3.6 Average Weight of fruiting body

The least weight of P. ostreatus sourced from the five individual bags of P. Ostreatus grown on Sawdust is clearly more than the weight of any of the bags gotten from the Corn cob substrate. This is also clearly shown by the big difference in their averages.

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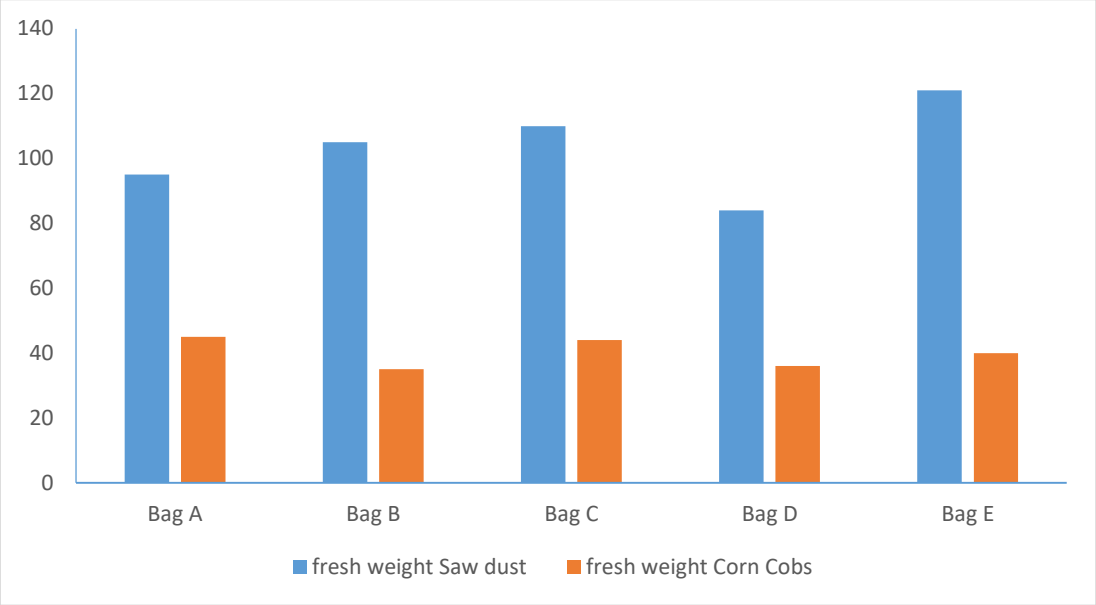

Fig. 3.2 Average weight of fruiting body

3.7 Average Height of the fruiting bodies in each bag

The Average height of the fruiting bodies is slightly higher in corn cob substrate than that of the saw dust substrate.

Table 3.5 Average Height of the fruiting bodies in each bag

S/N	Bags	Saw dust (cm)	Corn Cob (cm)
1	A	5.2	5.0
2	B	4.9	5.1
3	C	5.0	5.0
4	D	4.8	4.9
5	E	4.9	4.7

3.4 Moisture analysis

After the moisture analysis were carried out in an oven the dry weight of P.ostreatus was measured using the same scale balance used for measuring the fresh weight and P.ostreatus from Saw dust was found to weigh 9grams while that of Corn cob was found to weigh 7grams. This showed that within the same period and temperature of subjection to drying, P. ostreatus lost 11grams equivalent of moisture content while P. ostreatus from corn cob lost 13grams, two grams more than P. ostreatus from saw dust. This indicates that P. ostreatus from sawdust possesses the capacity to retain more moisture than P. ostreatus from corn cob.

The summarized result of fresh weights, dry weight, moisture content, cap diameter and stripe diameter show that sawdust substrate give higher yield of P. ostreatus than Corn cobs substrates as shown in Table 3.1. and 3.2 while Table 3.3 showing the mean values.

Table 3.6 Yield Attribute of *P. Ostreatus* on Sawdust Substrate

Harvested Mushroom from Sawdust	Fresh Weight (G)	Dry Weight (G)	MC (G)	Cap Diameter (Cm)	Strip Diameter (Cm)
A	95	10	85	6	7
B	105	11	94	8	7
C	110	13	97	5	8
D	84	9	75	5	7

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E	121	14	107	7	9
Average	103	11.4	91.5	6.2	7.6

Table 3.7 Yield Attribute of *P. Ostreatus* on Corn Cobs Substrate

Harvested Mushroom from Corn Cobs	Fresh Weight (G)	Dry Weight (G)	MC (G)	Cap Diameter (Cm)	Strip Diameter (Cm)
A	45	4	41	2	4
B	35	3	32	2	3
C	44	2	42	3	4
D	36	2	34	3	5
E	40	3	37	2	4
Average	40	2.8	37.2	2.4	4

Table 3.8 The Yield of the P. Ostreatus Grown on the different substrates (Sawdust and Corn Cobs) at the Frequency of watering of 30 litres per week

Harvested Mushroom	Fresh Weight (G)	Dry Weight (G)	MC (G)	Cap Diameter (Cm)	Strip Diameter (Cm)
Sawdust	103	11.4	91.6	6.2	7.6
Corn cobs	40	2.8b	37.2	2.4	4

Plate 1 P. ostreatus (Sawdust*)*

Plate 2 P. ostreatus (Corn cob*)*

The total biological weight of the P. ostreatus on sawdust was more than that of P. ostreatus on corn cob with sawdust recording a value of 121g and a low fresh weight of 84g, while corn cob recording a high fresh weight of 45g and a low fresh weight of 35g. P. ostreatus from sawdust also recorded higher values in Biological efficiency than P. Ostreatus in corn cob. The average time of harvest was calculated at 26 days for both substrates.

The total number of effective fruiting bodies for each bag were counted and recorded. The Sawdust substrate recorded less on average (9.2) against the corn cob substrate (12.8). The average fresh weight of the fruiting body were 103g for Sawdust substrate and 40g for the Corn cob substrate. This indicates a great disparity in the weight and quality of the mushroom produced on the Sawdust substrate against that produced on the Corn cob substrate.

Moisture analysis indicated that there were a greater loss of moisture content in the mushrooms propagated on the Corn cob Substrate than those propagated on the sawdust substrate. Considering the fact that the same weight of mushroom were subjected to drying from both substrates, P. ostreatus from Sawdust indicated a

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higher ability to retain moisture more than P. ostreatus from Corn cob. The yield attribute of fresh weight on sawdust gave 95g on substrates A while substrate E recorded the highest fresh weight of 121g. Substrate A recorded 14g in dry weight, moisture content while that of E was 107g, cap diameter was recorded 8cm which was the highest as shown in Table 1.

IV. CONCLUSION

It is seen from the result that *Pleurotus ostreatus* gave higher yield on sawdust substrates while on the corn cobs substrates the yield was less. Though there were no significant difference during growth initiation on the different substrates.

V. RECOMMENDATIONS

The study recommend that sawdust substrate is preferable for the cultivation of *Pleurotus ostreatus* to corn cobs substrate as the former gives higher yield of *Pleurotus ostreatus.*

It also recommended that both substrate be mixed in equal proportion and prepared as a substrate where the yield of *Pleurotus ostreatus* will be observed. This will also reduce agricultural waste and environmental pollution.

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