EFFECTS OF SAW DUST SUBSTRATE ON THE GROWTH, YIELD PERFORMANCE AND ECONOMIC RETURN OF TWO STRAINS OF MUSHROOM *(PLEUROTUS SPECIES)* IN NIGERIA

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Abstract

The study was designed to determine the effect of oyster mushroom strains on growth performance: Implication for commercial mushroom enterprise in Nigeria. The study was done at the Teaching and Research Farm of the Department of Agricultural Education, Federal College of Education (Technical) Omoku, Rivers State. The experimental design adopted was Randomized Complete Block Design (RCBD) with two (2) treatments (oyster and oyster king) mushroom strains each replicated three (3) times and the duration of the experiment was 150 days. The substrate used was saw dust blocks in a building (indoor cultivation method), the saw dust was treated with heat before storing in thirty (30) cm long and seven (7) cm diameter polythene bags. The spawn preparation was done for two strains in a dark room and stored in air tight bottles for cultivation. Measurements were taken on rate of colonization, rate of sprouting, rate of fruiting and fresh harvested mushroom weight yield. Data were analysized using mean and hypotheses were tested using t-test analysis. It was observed that the two strains of Pleurotus differ in rate of colonization, oyster strain took less than 21days to completely colonize the block, and rate of sprouting was 100% at 90 days and rate of fruiting was 92% at the end of the experiment. The results showed that there was significant difference in the rate of colonization, sprouting rate, rate of fruiting and fresh harvested mushroom weight yield (p=0.05). It was concluded that with saw dust block as substrate oyster strain performs better than oyster king. It was recommended that oyster strain should be used for commercial mushroom production in Nigeria.

Keywords: oyster, mushroom, enterprise, colonization, fruiting

Introduction

The knowledge of feed stuff and nutrient composition has open doors to domestication of many wild plants and animals. This knowledge also helps to promote the upgrading of many agricultural practices and production strategies. In last few decade different innovative farming practices such as snail farming, bee farming, cane rat farming, butterfly farming and mushroom farming are taking the central stage for protein supply. Culinary mushrooms have been known to human in many cultures for many years because of their medicinal and nutritional values. (Cheng, 2007)

Mushrooms have been appreciated for their nutritional properties, economical and ecological values and medicinal properties (Thanh & Senaratine, 2020). They produce many useful secondary metabolites, high protein content with essential amino acids, vitamins, minerals and exopolysaccharides (Adebayo-Tayo, et al., 2011).Cheng (2007) asserted that mushroom species contain a wide range of metabolites like anti-tumour, anti-genotoxic, anti-oxidant, anti-hypertensive, anti-platelet aggregating, and anti- hyperglycemic, anti-microbial and anti-viral substances(Khan & Tania 2012; Tolera & Abera, 2017). Culinary mushrooms belong to various species like chanterelles (*Canthare spp*.), shiitake (*Letinula spp*), morals (*Morchella spp*), and oyster (*Pleurotus spp*.) (Mowsumi & Choudhury, 2010).

The main source of these mushrooms for years was the wild but today domestication of different species of edible mushroom has been established. The cultivation, production and application of mushroom are tremendously increasing very fast throughout the world, mainly due to their nutritional properties and medicinal attributes; also, their unique flavour and texture (Ares, et al., 2007; Saiful &Wan 2016). One of the most popular cultivated culinary mushroom species is *Pleurotus* commonly called oyster mushroom. The name oyster came from the shape of gill which is a broad fan or oyster shaped. *Pleurotus sp*. is an aromatic edible fungus and there are many varieties and strains of these oyster mushrooms (Boa, 2004). Notable among them are *grey oyster mushroom (Pleurotus pulmonarius),* white oyster mushroom *(pleurotus ostreatus), P.*

giganteus, P. florida, P. eous, P. eryngii, P. sajor-caju, P. citrinopileatus and P. flabellatus (Raman et al., 2020; Kortei*et al*., 2015, Ahmed *et al*., 2016; Phan et al., 2012; Tolera & Abera 2017; Khan & Tania 2012).

Reis et al. (2012) reported that some species constitute a very valuable protein source; like other edible mushrooms, oyster is rich in polysaccharides, water soluble vitamins, macro and micro minerals and other biochemical substances in addition to microbial protein (Szabová, et al.2023; Mowsumi & Choudhury, 2010). Mushroom farming has a short gestation, relative low technology and low input requirement and less land utilization. With economic, medicinal and nutritional potentials of this edible mushroom species, opportunity has been created for commercial mushroom production enterprise that would enhance food security and improve the standard of living.

The global mushroom cultivation market has been projected to witness significant growth, majorly due to its growing acceptability and rising demand across the world Mushroom cultivation has great scope in China, India and in some of other developing countries because of the cheap and easily available raw materials needed for this activity, coupled with faster means of communication and marketing (as a fresh commodity), and better purchasing power of the people ((Koyyalamudi, et al., 2009). In Nigeria, though it is an essential vegetable with medicinal value, the produce regularly grows in the wild like a weed, with only a small fraction of farmers properly cultivating and harvesting it for food and commercial purposes (Gbenga, 2021). Mushroom hunting has been a long game practice among various tribes in Nigeria. This wild hunting is still practice in most rural settlements where ecological conditions allow the sprouting and fruiting of different edible mushroom. Almost the entire rural community may engage in one economic activity or the other during such fruiting season such hunting, transporting, selling or farm gate assembling. Lodge, et al. (2004) asserted that about 71% of women and children depend on mushroom obtained from the wild for season but sustainable small-scale business. This percentage might have increase or change now with the increase in poverty and unemployment rates. According to the National Farmers Information Service (NAFIS), Nigeria produces 300 tons of mushrooms yearly, against a demand of 1,200 tons, leaving a deficit of 900 tons

Commercial mushroom production enterprise has potential for income generation, employment opportunities, effective environmental management and control, raw materials for industries. It also helps play part in eco-tourism and nutrients supply. It has been reported that mushroom farming has zero emission to the environment maintaining a dynamic balance within the ecosystem by turning waste into something useful in a sustainable manner (Ndem & Oku, 2016). Commercial mushroom could be achieved through using any of these cultivation methods namely cultivation on death tree trunk or log and cultivation on straw which may be indoor or outdoor.

Despite the numerous benefits of specific mushroom species and mushroom farming in generally, production is still hazy in many potential productive areas like Nigeria. The cultivation of mushroom is being influenced by many factors though the severity may differ from one region to another depending on environmental conditions and local climate created within the mushroom farm (in-door & out-door) (Khan & Tania 2012; Tolera & Abera 2017;). These factors in order of priority are quality of spawn, culturing strategies, culture media, temperature, relative humidity, sources of carbon and nitrogen (Thanh & Senaratine, 2020; Bahl.1988). Also, part of these factors are socio-economic potentials of the people which influence awareness, interest, trial and adoption (Ukpong, 2019).

Some of these factors could be manipulated or controlled but quality spawn could be achieved through sound decision making based on scientific inference. There are fundamental questions an intended mushroom farmer or investor needs to attempt answering before engaging in novel farming activities such as mushroom farming. The questions could be which edible mushroom species is the best to cultivate in my environment? Which edible mushroom has the best growth performance and what is the economic return on investment. The study was conceived to determine the growth performance and economic return of two commercially available mushroom strains of *Pleurotus* species; oyster and oyster king growth performance on saw dust substrate.

Materials and Methods

The experiment was carried out in the mushroom cultivation house of the Teaching and Research Farm of Department of Agricultural Education, Federal College of Education (Technical), Omoku, Rivers State. Omoku is located at latitude 5^0 20^1N and longitude 6^0 39^1E and the climatic condition is tropical monsoon, rain season starts from the month of April to October whereas the dry season November to March, agrarian, commercial and crude oil exploration are among the common economic activities. The study adopted Randomized Complete Block Design (RCBD)

with two treatments (oyster and oyster king) each replicated three (3) times and duration of the study was one hundred- fifty days. The cultivation house was constructed using blocks, thick aluminum roofing sheets, wood and metals. The mushroom rag was constructed using wood. Black water proof was used to block rays from the sun was from penetrating the inside of building (dark room). The saw dust was collected from Omoku Timbre Market; the spawns were purchased from Federal University of Technology Owerri, Imo state. The spawn preparation was done for two strains in a dark room and stored in air tight bottles for cultivation. The saw dust was sterilized with heat to reduce water content and micro-organisms using drum, the treated saw dust was used to filled the ploy bays measuring 30cm in height by 7.7cm in diameter measuring 44.19cm^3 in volume. Equal rate of spawns was used to inoculate each of the saw dust block and the openings closed with robber band and placed on the mushroom rag. Measurements were taken on rate of colonization, rate of sprouting, rate of fruiting and fresh harvested mushroom yield weight.

i) Rate of colonization was done by direct observation of spread and measuring the extent.

Rate of colonization $= distance\ spread\ x100 / original\ distance$

ii) Rate of sprouting was done by counting the blocks that sprout after complete colonization

iii) Rate of fruiting by marking saw dust blocks that are constantly producing in each block and replicate at each harvest as a proportion to the blocks inoculated or cultivated.

iv) Fresh harvested yield weight was determined using a digital weighing balance.

v) The economics of production was calculated using the prevailing market prices of involvement in the experiment (Labour, capital, housing, procurements, processing and transportation cost).

Results

Oyster and oyster king colonization on a saw dust block

Table1: Rate of colonization of oyster and oyster king mushroom strains on saw dust blocks

Duration/Variables	Oyster colonized rate (%)	King oyster colonized rate (%)	Difference in rate of colonization
1WAI	10.2 ±0.05	3.41±0.12	6.79
2 WAI	25.4± 0.16	5.4± 0.62	20
3 WAI	48± 0.23	15± 0.09	33
4 WAI	61.2 ± 0.7	35± 0.7	26.2
5 WAI	75.1 ± 0.13	47.3± 1.1	27
6 WAI	90.3 ± 0.11	56.4± 0.34	33
7 WAI	100± 0.43	64.8± 0.25	35.2

WAI means week after inoculation

Table 1 shows the colonization rate of oyster and oyster king mushroom strains at different period. A week after inoculation of the substrate revealed that colonization was, 10.2 and 3.41% for oyster and oyster king respectively; two weeks after inoculation the rate of colonization were 25.4 and 4.4% for oyster and oyster king respectively. At third, fourth, fifth, sixth and seventh weeks after inoculation, the rate of colonization was 48, 61.2, 75.1, 90.3 and 100% for oyster mushroom strain while that of oyster king were 15, 35, 47.3,56.4 and 64.8% respectively. The rate of colonization varies between the two oyster mushroom strains using saw dust block as substrate or growth medium. It could be deduced that the preparation, concentration and the ability of spawn to multiple and the micro climate of the mushroom houses are not the only factors responsible for colonization but factors like species, strains and kind of substrates affect the rate of colonization.

Sprouting rate of oyster and oyster king mushroom strains.

Table 2: Sprouting rates of oyster and oyster king mushroom strains

Duration/Variables	Oyster sprouting rate (%)	Oyster king sprouting rate (%)
4 WAI	0	0
8WAI	16	0
12 WAI	67	15.2
16 WAI	89.2	27.4

WAI means weeks after inoculation

Table 2 shows the rate of sprouting weeks after inoculation (WAI); at four (4) weeks after inoculation, the rate of sprouting was 0% for both oyster and oyster king, at eight (8) weeks after colonization the rates were 16 % and 0 % for oyster and oyster king mushroom strains. Also, at twelve (12) weeks after colonization, the rates of sprouting were 67% and 15.2 % for oyster and oyster king mushroom strains respectively while at sixteen (16) weeks after inoculation, the rates were 89.2% and 27.4 % for oyster and oyster and oyster king respectively. It could be deduced that oyster mushroom strain initial sprouting faster than oyster king mushroom, this may be attributes of genetic composition, kind of substrate, organic substances interference and other environmental variables.

Fruiting rate of oyster and oyster king mushroom strains

Table 3: Fruiting rate of oyster and oyster king mushroom strains

Duration/Variables	Oyster fruiting rate (%)	Oyster king fruiting rate (%)
4 WAI	0	0
8 WAI	10±0.14	0
12 WAI	53± 3	6±0.6
16 WAI	71± 2	18±0.34
20 WAI	86± 0.23	49±0.03

WAI means weeks after inoculation

Table 3 shows fruiting rate at four (4) weeks after inoculation were 0% and 0% for oyster and oyster king mushroom strains, at eight (8) weeks after inoculation were 10% and 0% for oyster and oyster mushroom strains; at twelve(12) weeks after inoculation were 53% and 6% for oyster and oyster king mushroom strains; at sixteen(16)weeks after inoculation were 71% and 18% for oyster and oyster king mushroom strains and at twenty (20) weeks after inoculation were 86% and 49% for oyster and oyster king mushroom strains respectively. It could be deduced from the result that the two strains of oyster were fruiting at different rates but oyster strain fruits faster than oyster king. It could also be deduced from the result that sprouting does not always translated to fruiting.

Fresh harvested yield weight

Table 4: Fresh harvested yield weight of oyster and oyster mushroom strains

variables	Oyster fresh harvest yield ($kgha^{-1}$)	Oyster king harvest yield ($kgha^{-1}$)
1st harvest	8±0.3	0 ±
2nd harvest	19±0.2	0±
3rd harvest	32.1±3	5±0.07
4th harvest	35.3±2	11.4±0.01
5th harvest	41.43±0.4	15.02±0.04
6th harvest	44.10±0.06	18.24±1
7th harvest	45±1	20±0.5
8th harvest	45.4±0.03	25±2
9th harvest	46±0.34	29.7±0.08
10th harvest	46.32±0.21	34.4±0.02
Total yield	362.65	133.76
Average yield	36.27	13.38

Table 4 shows each harvest fresh yield weight of oyster and oyster king mushroom strains per hectare of land. At first harvest, fresh yield mushroom were 8 kg ha^{-1} and 0kgha-1 for oyster and oyster king respectively. At second harvest, the yields were19 kg ha^{-1} and 0kg ha^{-1}; third harvest yields were 32.1 kg ha^{-1} and 5kg ha^{-1};at fourth harvest 35.3 kg ha^{-1} and 11.4 kg ha^{-1} and at fifth harvest 41.43kg $ha^{-1}$and 15.2 kg ha^{-1} were the yield for oyster and oyster king respectively. Also, at sixth (6) harvest 44.1kg ha^{-1} and 18.24kg ha^{-1}; seventh (7) harvest 45kg ha^{-1} and 20kg ha^{-1} ; eight(8) harvest 45.4kg $ha^{-1}$and 25kg ha^{-1};ninth (9)harvest 46kg ha^{-1} and 29.7kg ha^{-1} and tenth (10) harvest 46.32kg ha^{-1} and 34.4kg ha^{-1}.From the result, the following deduction are made that there was increase in kg ha^{-1} of fresh yield mushroom from first harvest to last harvest for oyster mushroom strain but oyster king had no mushroom yield at all during the first and second harvests though from third harvest there was numerical increase. Oyster king mushroom strain displays low yield and slow grow rate. Total yield of oyster mushroom strain per hectare of landwas 362.65kg ha^{-1} three (3) higher than oyster king mushroom strain. It could be deduced from that oyster mushroom yield higher than oyster king but oyster king mushroom larger in shape than the ordinary oyster mushroom.

Economics of production of oyster and oyster king mushroom strains

Table 5: Economics of oyster and oyster king mushroom strains production

Variables/strains	Oyster	Oyster king
Total kg of mushroom produced	362.65	133.76
Total cost of production (₦)	127,155	127,155.00
Average cost per kg mushroom produced (₦)	350.63	950.62
Sales per kg (₦) 500	181,325.00	66,880.00
Returns on production (₦)	54,170.00	-60,275.00

Table 5 shows the total cost production in naira as ₦127,155.00 for oyster mushroom and oyster king mushroom strains; average cost per kg of mushroom stood at ₦350.63 and ₦950.62 for oyster and oyster king strains respectively; sales per kg at ₦500.00 for both strains and returns on production stood ₦54,170.00 and -₦60,275.00 for oyster and oyster king mushroom strains. At one hundred and fifty (150) days which is the expected date of peak production, oyster mushroom strain gave more returns than oyster king but beyond this duration may be oyster king would give equal or more then oyster mushroom. The observed findings may be responsibilities of substrates, spawn and environment. The findings are in tandem with Thanh *et al*. (2020) who observed that different culture media had different supporting effect on the growth of different *Pleurotus* mushroom species. For fast growth, high yield and short gestation period oyster mushroom should be used in commercial mushroom production.

Discussions

The colonization rate of 10.2, 25.4, 48, 61.2 75.1 and 1100 % were recorded for oyster mushroom at w 4, 8, 12, 16 and 20 weeks after inoculation (WAI) but 3.41, 4.4,15, 35 47.3, 56.4 and 64.8% were recorded for oyster king at the same period..The rate of colonization progressively varies between the two oyster mushroom strains on saw dust block substrate. It could be deduced that the observed may be due to preparation strategies, concentration of spawn on saw block and the ability of spawn to multiple influence the rate of colonization. Also, factors may be the micro climate of the mushroom houses, species, strains and kind of substrates. The findings were in line with Thanh *et al*. (2020) who reported that mushroom species, method of culturing and culture media or substrate influence the rate of colonization.

The two strains of oyster were fruiting at different rates but oyster strain fruits faster than oyster king. Also, some withered and died without fruiting that is some sprouting were not always translated to fruiting. The findings are in consonant Maz al Munsur, *et al*. (2012) who asserted mycelia growth is influenced by mushroom species and the substrate used and micro climate of the mushroom environment. The findings are also in consonant with Tolera and Abera (2017), they reported on various conditions that influence sprouting and fruiting of mushroom.

The oyster mushroom had higher yielded than king oyster. Total yield of oyster mushroom strain per hectare of land was 362.65kg ha^{-1} three (3) higher than oyster king mushroom strain. It could be deduced from that oyster mushroom yield higher than oyster king but oyster king mushroom larger in shape than the ordinary oyster mushroom. The observed are in tandem with Reis et al. (2012) who reported that different species of

mushroom perform differently and that substrates influence their growth pattern. The findings are also in line with Adebayo – Tayo *et al*. (2011) who asserted there are ideal conditions for mycelia growth such as temperature, moisture, relative humidity and ventilation.

The result on returns on cost of production indicated that oyster mushroom strain gave higher returns on cost of production than oyster king strain. The returns on production stood at ₦54,170.00 and minus (-) ₦60,275.00 for oyster and oyster king mushroom strains. The observed findings may be responsibilities of substrates, spawn and environment. The findings are in tandem with Thanh et al. (2020) who observed that different culture media had different supporting effect on the growth of different Pleurotus mushroom species. For fast growth, high yield and short gestation period, oyster mushroom should be used in commercial mushroom production.

Conclusion

Oyster mushroom displayed better colonization, sprouting rake fruiting rate, fresh yield weight and economics of production than oyster king. For commercial mushroom production enterprise oyster mushroom is recommended and that different substrates could be used for further trials**.**

Recommendations

The following recommendations were made

1. Oyster mushroom species is recommended for mushroom cultivation in Nigeria.
2. Big size poly- bags should be used for mushroom cultivation
3. Different types of agro waste should be used for mushroom culture.

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