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Cultivation and Yield Performance of *Hypsizygus ulmarius* Grown on Agricultural Waste from *Musaceae Family*

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Abstract

In Nigeria and other developing countries of the world, tonnes of agricultural and domestic waste are generated annually which are of no economic value, Mushrooms are cultivated directly or indirectly on agricultural waste products or compost. This is one of the most hygienic processes to recycle agro-wastes. This study investigated the cultivation and yield performance of *Hypsizygus ulmarius* grown on agricultural waste from *Musa sapientum* (MS), *M. paradisiaca* (MP), *M. accuminata* (MA), MS+MP, MS+MA, MP+MA, MS+MP+MA. The completely randomized design was used. Statistical Analysis of Variance was carried out at 95% level of significant while NDMRT was used to separate the means. The result showed that MS+MA had the shortest fruiting time of 12 days while MP, MP+MA had the longest, which was 14 days. The largest capsize was obtained in MP while the smallest capsize was in MA. The longest stipe length was produced by MS+MP while MS+MA have the shortest stipe. MP+MA substrates gave the highest biological yield while the least was recorded by MS+MA. Biological Efficiency was best at 76.58% produced by MP+MA and lowest at 56.48% by MS+MA. The results obtained indicate that *H. ulmarius* can be easily grown on the above mentioned substrates. In addition, the substrates used for the growth of *H. ulmarius* are recommended for use by farmers and other people interested in mushroom cultivation.

Keywords

Mushroom, Agro-waste, Cultivation, Biological Yield, Biological Efficiency

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1. Introduction

Mushrooms are usually picked from the wild during the latter wettest part of the rainy season, where they are found growing on deeply decomposing organic matter, their unavailability during the remaining part of the year as well as changes in the climatic patterns, has made it difficult harvesting wild mushrooms [2]. This presents a window of opportunity has which has led to its artificial cultivation. Mushroom cultivation is a profitable agri-business, which stemmed from the realization that the incorporation of non-conventional crops in existing agricultural systems can help in improving the social as well as the economic status of humans [1].

Mushroom can be grown on various agricultural wastes with the use of different technologies. Mushroom substrate may be defined as some kind of lignocellulose rich materials which supports the growth, development and fruiting of mushroom [3]. These substrate materials are usually by-products from industries, households, agriculture etc., and are usually considered as wastes [10]. However, these wastes are actually resources in the wrong place at a particular time and mushroom cultivation can harness them for its own benefit [5]

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Hypsizygus ulmarius (Bull.:Fr.) Redhead, also known as 'blue oyster' or 'elm oyster' is a high yielding mushroom with less popularity. This mushroom has wide uses due to its unique flavour, nutritive value and medicinal properties [4]. This mushroom is wide spread throughout the temperate forests of eastern North America, Europe and Japan. It is a saprophyte on elms, cotton woods, beech, and maple willow, oak and occasionally on other hard woods. It grows solitary or in small clusters on living hardwoods, particularly elm (*Ulmus*) and box elder (*Acer negundo*). This mushroom closely parallels the morphology of oyster mushroom but it is far better in flavour and texture [15]. Cultural, physiological and spawn characters of *H. ulmarius* were studied by Wange and Patil (2007) [18]. Tom Volk's (2003) reported that *H. Ulmarius* was first named as *Pleurotus ulmarius* and later as put under genus *Hypsizygus* as *Pleurotus* species cause white rot and *Hypsizygus* cause brown rot.

This study was designed to investigate the cultivation and yield performance of *Hypsizygus ulmarius* on agricultural waste from the *Musa paradisiaca, Musa sapientum* and *Musa accuminata* used singly and in combinations so as to recommend the best substrate to mushroom growers for use in the domestication of the mushroom and the production of quality and quantity fruit-bodies of same.

2. Materials and Methods

2.1. Study Area

This study was conducted in the mushroom house/laboratory of the Department of Plant Science and Biotechnology, Michael Okpara University of Agriculture Umudike, Abia State.

2.2. Source of Materials

Hypsizygus ulmarius spawn was supplied by Dr Magnus Nwoko, of the Department of Plant Science and Biotechnology, Michael Okpara University of Agriculture Umudike, Abia State. The substrates used were dried leaf midribs of three species from the Musaceae family namely *Musa sapientum, M. paradisiaca* and *M. accuminata* from Amawom in Ikwuano L. G. A of Abia State.

The substrates were dried leaf midribs of three species from the Musaceae family namely *Musa sapientum, M. paradisiaca* and *M. accuminata* used singly and in combinations. These dried substrates were chopped into pieces of about 2cm long using machete.

They were then soaked in water before being pasteurized in a gas heated drum for two hours. The treatments were made of *M. sapientum* (MS), *M. paradisiaca* (MP), *M. accuminata* (MA), MS+ MP, MS + MA, MP + MA and MS+ MP+ MA. Equal amount of each substrate were used in each mixture. Perforated buckets were used for the cultivation. These buckets were filled with 200g of the substrate inoculated with the grain spawn of *H. Ulmarius* and they were covered with their lids and placed in the wooden racks in mushroom house [13].

2.3. Experimental Design and Statistical Analyses

This experiment was carried out using completely randomized design having seven treatments and four replicates each. Replicate readings obtained were analyzed for significance using Analysis of Variance (ANOVA) at 95% significance level while NDMRT was used for separation of means.

2.4. Measurement of Parameters

The growth of the mushrooms in each of the treatments was recorded. Data was collected from the fruit-body. The yield of the mushrooms from the different treatments involved were determined in terms of the

1. stipe length (cm),
2. Cap diameter (cm)
3. Fruiting Time (days)
4. Biological Yield: Weight of fresh mushrooms harvested (g) per substrate weight
5. Biological Efficiency: {Weight of fresh mushrooms harvested (g)/substrate weight (g)} × 100 [10].

3. Result

3.1. Fruiting Time

The fruiting time was recorded from the time of inoculation of the spawn into the different substrates as shown in Figure 1.

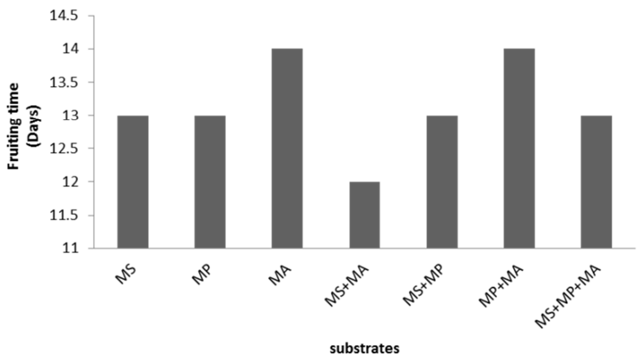

Figure 1. Effect of substrates and substrates combination on the fruiting time of *H. ulmarius* mushroom.

Figure 1. Shows the effects of the substrates and substrates combination on the fruiting time, the MS+MA substrate was

the first to produce pinhead having the shortest fruiting time of 12 days, followed by MS, MP, MS+MP and MS+MP+MA all having a fruiting time of 13 days while MA and MP+MA had a fruiting time of 14 days being the last substrates to produce pinhead among the different treatments. There was no significant difference between the results.

3.2. Cap Diameter

Figure 2 shows the effect of substrates and substrates combination on the cap diameter of *H. ulmarius* mushroom. The result for the capsize produced by the different substrates are 5.02cm, 5.86cm, 4.40cm, 4.72cm, 5.16 cm, 5.10cm, 4.74cm for MS, MP, MA, MS+MA, MS+ MP, MP+MA and MS+MP+MA respectively. MP (5.86cm) had the largest average capsize while MA (4.40cm) had the least capsize.

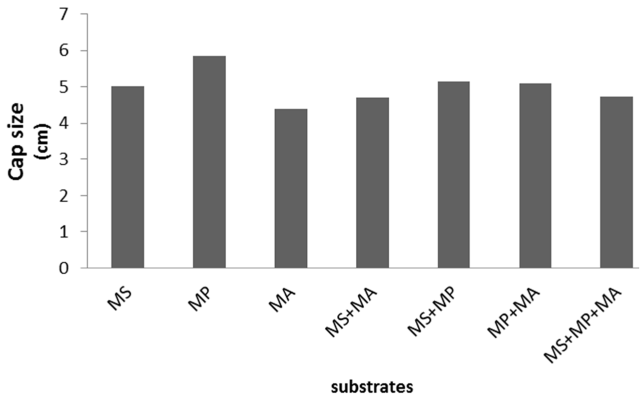

Figure 2. Effect of substrates and substrates combination on the cap size of *H. ulmarius* mushroom.

3.3. Stipe Length

Figure 3 shows the results of the stipe length of *H. ulmarius* recorded by the different substrate and substrates combination. The result are 2.53cm,2.59cm, 2.40cm, 2.28cm, 2.76 cm, 2.49cm, 2.42cm MS, MP, MA, MS+MA, MS+ MP, MP+MA and MS+MP+MA respectively. MS+MP (2.76cm) had the longest average stipe length while MS+MA (2.28cm) produced the least stipe length.

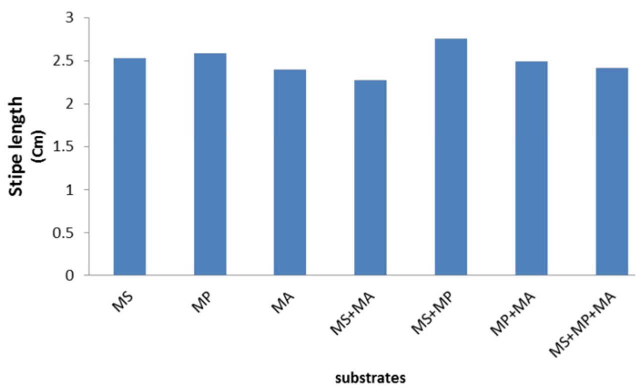

Figure 3. Effect of substrates and substrates combination on the stipe length of *H. ulmarius* mushroom.

3.4. The Biological Yield

Figure 4 shows the results of the biological yield of *H. ulmarius* recorded by the different substrate and substrates combination. The result are 149.80g, 130.82g, 125.80g, 112.95g, 145.47g, 153.14g and 135.96g MS, MP, MA, MS+MA, MS+ MP, MP+MA and MS+MP+MA respectively. MP+MA (153.14g) had the highest biological yield while MS+MA (112.95g) had the lowest biological yield.

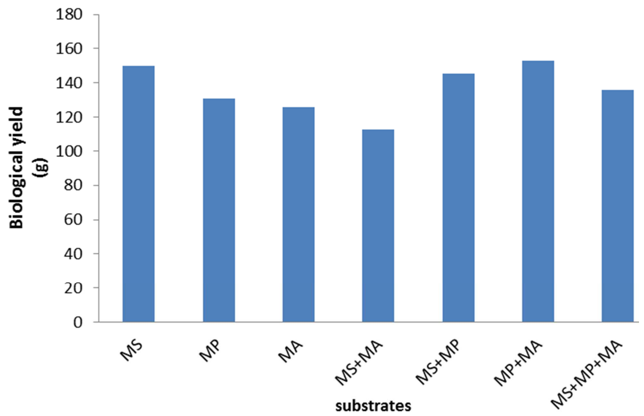

Figure 4. Effect of substrates and substrates combination on the biological yield of *H. ulmarius* mushroom.

3.5. Biological Efficiency

Figure 5 shows the results of the biological efficiency of *H. ulmarius* recorded by the different substrate and substrates combination. The result are 74.89%, 65.41%, 62.90%, 56.48%, 72.75%, 76.58% and 67.98% for MS, MP, MA, MS+MA, MS+ MP, MP+MA and MS+MP+MA respectively. MP+MA (76.58%) had the highest biological efficiency while MS+MA (56.48%) recorded the lowest biological efficiency. The statistical analysis showed no significant difference between the treatments.

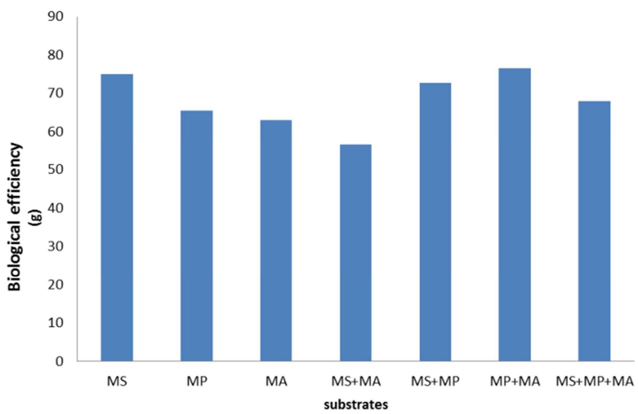

Figure 5. Effect of substrates and substrates combination on the biological efficiency of *H. ulmarius* mushroom.

4. Discussion

The results showed a lower number of days compared to Usha and Suguna (2015) who reported a longer time for pinhead formation in *H. ulmarius* [17]. The number of days for pinhead formation were also lesser than that reported by Sharmila et al. (2015) who worked on *P. ostreastus* and Mondal et al. (2010) reported lesser number of days for pinhead formation [12, 8]. The results showed that the days to pinning greatly depends on the substrate and the highly productive substrates like MP+MA came into production later than the less suitable substrates. The tendency of the poorer substrates to pin earlier is attributed to nutritional stress that mycelium is subjected to [9].

Cap diameter and stipe length depends on amount of aeration and light [7]. During this study, it was observed that the two parameters also depend on the length of time taken from pinhead appearance to harvesting in addition to the substrate type. It was observed that pileus diameter was very much dependent on the number of caps per cluster. The fewer they were, the wider the diameter due to lower competition for space and available nutrients. The cap diameter reported in Figure 2 were larger and the stipe length (Figure 3) was lower than those reported by Ajonina and Tatah (2012) [1]. Zadrazil (1978) cited in Mondal et al. (2010) stated that the higher the stalk length, the poorer the quality of the mushroom [19, 8].

The biological yield and biological efficiency shown in figure 4 and figure 5 showed that MP+MA substrate had the highest mushroom yield and biological efficiency, but more time was taken for production of fruiting bodies. Sumi (2016) recorded a biological yield and biological efficiency for *H. ulmarius* in paddy straw higher than what was obtained in this present study [14]. The lowest yield was recorded from mushrooms grown on MS+MA substrates, which is higher than the lowest biological yield and biological efficiency recorded by Sumi (2016) [14]. This was also in accordance with the findings of Karnawadi (2006) who reported the lowest biological yield and biological efficiency of *Pleurotus* spp. in beds made from sugarcane bagasse [6].

5. Conclusion and Recommendation

The elm oyster mushroom is an excellent edible mushroom which can be easily grown either for commercial purpose or for home. *Hypizygus ulmarius* fruit bodies were successfully cultivated on agro-wastes from *Musa paradisiaca, Musa sapientum* and *Musa accuminata* singly or in combinations. Commercialization of mushroom cultivation using the substrates in this study should be encouraged since these substrates are readily available in our locality.

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